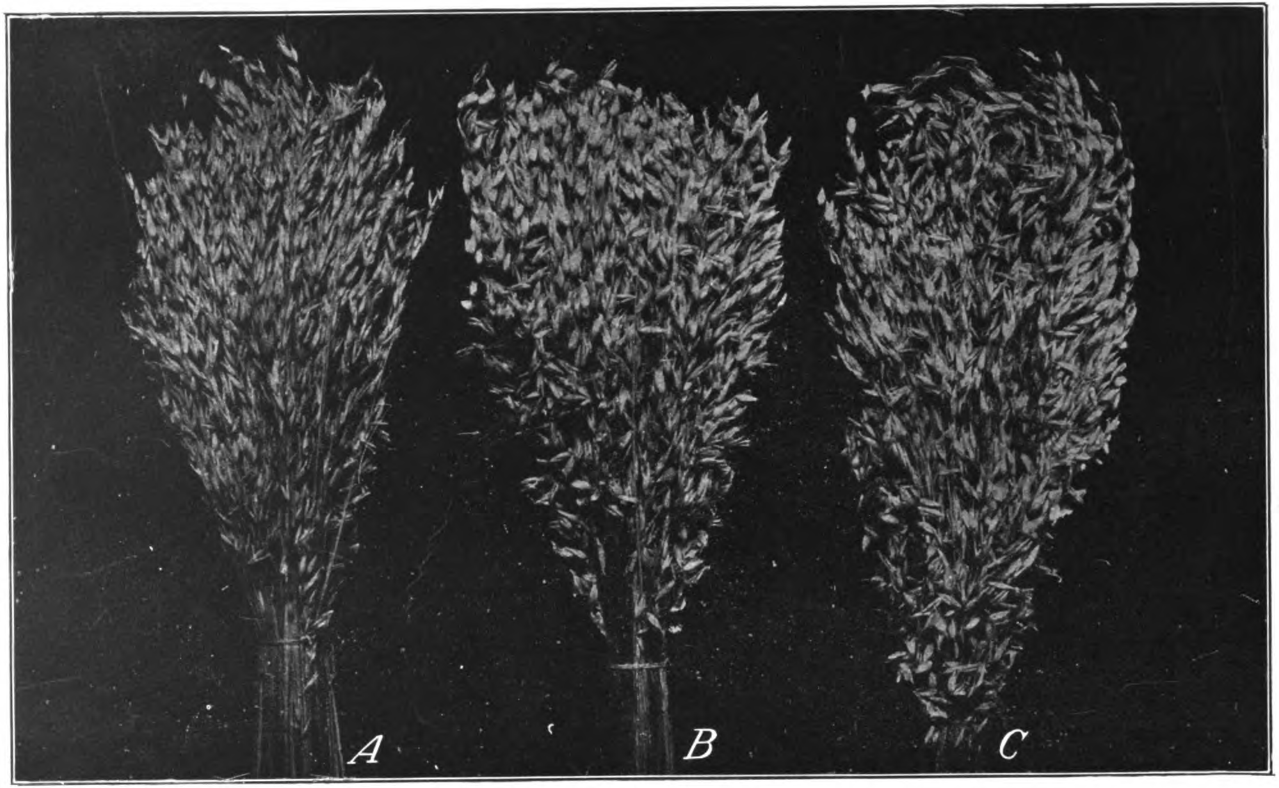
Abridged Agricultural Records in Seven Volumes



Three Varieties of Oats Introduced by U. S. Department of Agriculture: A, 60 Day; B, Swedish Select; C, North Finnish Black.

FARMERS' CYCLOPEDIA

ABRIDGED AGRICULTURAL RECORDS

IN SEVEN VOLUMES

From the Publications of the

UNITED STATES DEPARTMENT OF AGRICULTURE

AND

THE EXPERIMENT STATIONS

A Compilation of such Bulletins and Reports as are Indispensable to the Practical Farmer

---

VOLUME IV

GRASS, HAY, GRAINS, VEGETABLES

GARDEN CITY NEW YORK
DOUBLEDAY, PAGE & COMPANY
1914

ACKNOWLEDGMENT

THE WRITINGS of the following authorities were consulted or abridged, or both, in the preparation of this volume:

Department of Agriculture.—Beverly T. Galloway, Albert F. Woods, Erwin F. Smith, Charles P. Hartley, Archibald D. Shamel, Walter T. Swingle, Rodney H. True, Thomas H. Kearney, Orator F. Cook, Nathan A. Cobb, Frederick V. Covillo, William J. Spillman, Mark A. Carleton, A. C. True, Charles O. Townsend, Carl S. Scofield, Lee C. Corbett, E. Channing Chilcott, William W. Tracy, David Fairchild, Charles V. Piper, Edgar Brown, John D. Shanahan, Ernst A. Bessey, August Mayer, Seaman A. Knapp, Milton Whitney, William A. Taylor, Lyster H. Dewey, E. M. Byrnes, Bradford Knapp, J. W. T. Duvel, W. A. Orton, Charles V. Piper, W. W. Garner.

Alabama.—P. H. Mell, J. F. Duggar, F. E. Floyd, J. T. Anderson.

Arizona.—R. H. Forbes, John A. Thornber, R. W. Clothier, G. F. Freeman.

Arkansas.—R. L. Bennett, W. G. Vincenheller, George E. Cole, Martin Nelson, J. L. Hewitt.

California.—E. W. Hilgard, W. A. Setchell, R. H. Loughridge, Ralph E. Smith, G. W. Shaw, H. M. Hall.

Canada.—J. S. Duff, C. C. James, S. B. McCready, W. H. Day, J. E. Howitt, C. F. Bailey, F. C. Hart, J. L. Hilborn, W. J. Squirrell, J. Lockie Wilson, F. G. Raynor, A. G. McKenzie, G. B. McCalla, W. H. Peters, W. J. Black, S. A. Bedford, G. E. Day.

Colorado.—Walter G. Sackett, William P. Headden, Philo K. Blinn, George H. Glover, E. R. Bennett, W. H. Olin, Wendell Paddock, H. H. Griffin, Joseph Reed, F. M. Rolfs, J. E. Payne, W. W. Cooke, C. S. Crandell, Allston Ellis, Alvin Keyser.

Connecticut.—L. A. Clinton, W. M. Esten, Charles Thom, E. A. White, B. B. Turner.

Delaware.—A. T. Neale, M. T. Cook, A. E. Grantham, C. O. Smith, T. D. Chester.

Florida.—T. H. Taliaferro, H. K. Miller, C. M. Conner, P. H. Rolfs, H. S. Fawcett.

Georgia.—Martin V. Colvin, H. C. White, J. M. Kimbrough, C. A. McLendon, J. C. Temple, R. J. Redding.

Hawaiian Islands.—E. V. Wilcox, J. J. Vernon, F. G. Krauss, E. O. Wooten, Luther Foster.

Idaho.—Hiram T. French, Louis F. Henderson, John S. Burd.

Illinois.—Cyril G. Hopkins, Eugene Davenport, J. H. Pettit, Henry L. Rietz, A. N. Hume, O. D. Center, Leonard Hegnauer, Edward, M. East, A. D. Shamel, John W. Lloyd, J. S. Brooks, A. C. Beal, Robert Stewart.

Indiana.—Arthur Goss, W. C. Latta, J. C. Arthur, A. T. Wiaucko.

Iowa.—C. F. Curtis, James Wilson (present Secretary of the Department of Agriculture of the United States), L. H. Pammel, James Atkinson, D. A. Kent, M. L. Bowman, P. G. Holden.

Kansas.—Charles W. Burkett, H. F. Roberts, Albert M. Ten Eyck, H. M. Cottrell, A. S. Hitchcock.

Kentucky.—M. A. Scovell, W. H. Scherffius, George Roberts, J. N. Harper.

Louisiana.—W. R. Dodson, H. P. Agee, S. E. McClendon, F. C. Quereau, C. M. Edgerton.

Maine.—Charles D. Woods, W. J. Morse.

Maryland.—Harry J. Patterson, J. B. S. Norton, N. Schmitz, Milton Whitney, C. O. Townsend.

Massachusetts.—Henry H. Goodell, W. P. Brooks, Charles A. Groessmann, H. D. Haskins, George E. Stone.

Michigan.—Clinton D. Smith, J. D. Towar, J. A. Jeffery, W. L. Beal.

Minnesota.—Willet M. Hays, Andrew Boss, E. M. Freeman.

Mississippi.—W. R. Perkins, H. L. Hutchinson, E. R. Lloyd.

Missouri.—Henry J. Waters, J. M. Conner, E. D. Porter, George M. Tucker, B. M. Duggar, H. F. Miller.

Montana.—Samuel Fortier, F. B. Linfield, V. K. Chesnut, J. W. Blankinship, Robert S. Shaw, Alfred Atkinson, J. B. Nelson.

Nebraska.—Charles E. Bessey, F. D. Heald, Alvin Keyser.

Nevada.—J. E. Stubbs, R. H. McDowell, C. S. Knight, P. B. Kennedy.

New Hampshire.—Harry Hayward, F. W. Taylor, Charles Brooks, John C. Kendall, Frank W. Rane, Charles S. Murkland, H. H. Lamson.

New Jersey.—Edward B. Voorhees, B. H. A. Groth, Jacob G. Lipman, Charles S. Cathcart.

New Mexico.—C. T. Jordan, Charles Keffer, Luther Foster, E. O. Wooten.

New York.—J. P. Roberts, John W. Gilmore, W. H. Jordan, F. C. Stewart, H. J. Webber, E. G. Lodeman, John L. Stone, T. L. Lyon, T. F. Hunt, G. F. Atkinson, C. F. Hunn, L. A. Clinton, S. A. Beach, John Craig.

North Carolina.—C. B. Williams, F. L. Stevens, Gerald McCarthy.

North Dakota.—J. H. Worst, H. L. Bolly, J. H. Shepperd.

Ohio.—Charles E. Thorne, W. J. Green, J. F. Hickman, A. D. Selby, C. G. Williams, L. H. Goddard, H. A. Gossard, R. C. E. Wallace, T. F. Manus.

Oklahoma.—John Fields, F. C. Burtis, E. M. Wilcox, W. L. English, L. A. Moorehouse, J. F. Nicholson.

Oregon.—Thomas M. Gotch, James Withycombe, H. D. Scudder, E. R. Lake.

Pennsylvania.—H. P. Armsby, William Frear, W. A. Backhout, George C. Watson (who assisted in the abridgment of these volumes), F. D. Gardner, B. E. Brown, C. F. Shaw, C. F. Nall, W. H. MacIntire.

Rhode Island.—H. L. Wheeler, George E. Adams, S. C. Damon, Albert L. Whiting, F. R. Pember.

South Carolina.—J. N. Harper, C. L. Newman, H. W. Barre.

South Dakota.—E. C. Chilcott, James W. Wilson, C. Willis, E. W. Olive, W. A. Wheeler, D. A. Saunders.

Tennessee.—F. Lamson Scribner, Andrew M. Soule, Samuel M. Bain, John R. Fain.

Texas.—J. H. Connell, James Clayton, B. C. Pittuck, W. C. Welborn, H. L. McKnight.

Utah.—John A. Widtsoe, Lewis A. Merrill, J. A. Sanborn, J. C. Hogenson.

Vermont.—J. L. Hills, L. R. Jones, Stanley Hargreaves, Cassius Peck.

Virginia.—Andrew M. Soule, John R. Fain, Phares O. Vannater, J. M. McBride, S. W. Fletcher, H. S. Reed.

Washington.—Enoch A. Bryan, E. E. Elliott, R. W. Thatcher, George Severance, C. W. Lawrence, W. H. Lawrence, H. B. Humphrey, Leonard Hegnauer, Alexander Cadide, R. K. Beattie.

West Virginia.—J. H. Stewart, A. D. Hopkins.

Wisconsin.—W. A. Henry, S. M. Babcock, H. L. Russell, R. A. Moore, A. R. Whitson.

Wyoming.—E. E. Smiley, B. C. Buffum, A. Nelson, F. E. Emery, J. D. Towar, L. B. McWethy, T. S. Parsons.

TABLE OF CONTENTS

Part I.

GRASS AND HAY.

	Page
Principal Grasses	17
Timothy	17
Red Top	31
Alfalfa	32
Clover	59
Soy Bean	82
Velvet Bean	94
Cowpea	96
Millets	110
Grasses in General	116
Hay Grasses	117
Pasture Grasses	121
Lawn Grasses	126
Wet Land Grasses	127
Shifting Sand Grasses	129
Embankment Grasses	130
Forage and Fodder Plants	132
Other Grasses	162
Hay Making and Market	172
Timothy	186
Meadow Fescue	189
Canada Bluegrass	190
Millet	190
Alfalfa	192
Clover	194
Cowpea	200
Soy Bean	204
Sorghum	205
Grasses of Salt Marshes	207
Tame Hay Areas	208
Reckoning Value of Hay	211
Spontaneous Combustion of Hay	212
Authorities on Grass Consulted	215

Part II.

THE VEGETABLE GARDEN.

Its Importance	217
Location	218
Plan and Arrangement	218
Fertilizers	220
Preparation of the Soil	222
Time of Planting	223
Selection of Seed	223
Sowing and Planting	224
Tools	228
Mulching	228
Irrigation	233
Thinning	234
Transplanting	234
Setting in the Open Ground	235
Protection of Plants	236
Harvesting, Packing and Shipping	237
Canning Vegetables on the Farm	238
Storing	242
Early Plants in Hotbeds	244
Handling Plants	245
Frames Used in Truck Growing	246
Ventilation	248
Soil and Fertilizers	251
Watering Crops	251
Garden Products—	
Anise	252
Artichoke	252
Asparagus	252
Beans	257
Beans, Lima	263
Beets	264
Borage	265
Broccoli	265
Brussels Sprouts	266
Cabbage	266
Calabash	270
Cantaloupe	271
Cardoon	272
Carrot	273
Cauliflower	273
Celeriac	276
Celery	276
Cetewayo	283
Chayote	283
Chervil	283
Chicory	283
Chile	284
Chive	287
Citron	287
Collards	288
Corn Salad	288

TABLE OF CONTENTS

	Page
Cress	288
Cucumbers	288
Dandelion	292
Dill	293
Egg Plant	293
Endive	293
Fennel	294
Garlic	294
Ginger	294
Herbs	294
Horse Radish	295
Ice Plant	294
Kale	295
Kohl-Rabi	295
Leek	296
Lettuce	296
Lleren	296
Martynia	297
Melon—Muskmelon	297
Melon—Watermelon	302
Mustard	305
Nasturtium	305
New Zealand Spinach	306
Okra	306
Onions	308
Parsley	318
Parsnip	318
Peas	318
Peppers	319
Physalis	319
Potato	320
Pumpkin	343
Radish	343
Rhubarb	343
Ruta-Baga	344
Salsify	344
Scolymus	344
Skirret	344
Sorrel	345
Spinach	345
Squash	345
Stachys	345
Sweet Basil	346
Sweet Corn	346
Sweet Marjoram	346
Sweet Potato	346
Swiss Chard	355
Thyme	355
Tomatoes	355
Turnips	366
Vegetable Marrow	366
Composition of Roots	367
Authorities Consulted	367
Quantity of Seed to Plant	368

Part III.

FIELD CROPS.

Importance of Grain	370
Improving Plants by Selection and Breeding	370
Separation of Seed by Specific Gravity	379
Tillering of Grains	380
Shrinkage of Grains	382
Sulphur Bleaching of Oats and Barley	386
Weights of Seeds Per Bushel	389
Corn	400
Wheat	442
Oats	463
Barley	500
Rye	512
Emmer	513
Buckwheat	516
Pop Corn	519
Canadian Field Peas	520
Cowpeas	526

Part IV.

VARIOUS FARM PRODUCTS.

Weeds	530
Weeds Used in Medicine	553
Poisonous Plants	565
Promising Root Crops	581
Taro	581
Yautia	583
Goldenseal	586
Camphor	587
Cacao	587
Prickly Pear	588
Tuna	590
Australian Wattle	590
Sumac	591
Bamboo	591
Roselle	592
Rubber	592
Guava	595
Cocoanut	596
Yam Root	597
Ginseng	598

Part V.

MISCELLANEOUS CROPS.

Rice	600
Peanut	615
Hops	634
Mushrooms	650
Castor Bean	658
Canaigre	660
Banana	665

ILLUSTRATIONS

VOLUME IV.

	Page
Oats	*Frontispiece*
Alfalfa in Rows...........	33
Alfalfa, Threshing of......	33
Timothy Seed	51
Desert Lands Reclaimed....	69
Nodules	87
Hay Cocks Protected.......	105
Alfalfa Nodules	123
Clover Nodules	123
Alfalfa Crown Gall.......	123
Clover Crown Gall........	123
Mountain Bunch Grass....	141
Roselle Plant	159
Tobacco Fertilized	177
Field of Grass............	177
Experimental Plots	195
Seed Corn Ears...........	213
Corn, Hybrid Ear of.......	231
Gooseberries	249
Chili Wheat Straw........	267
Raspberry, Red	285
Boys' School Exhibit.......	303
Jerry Moore's Corn........	303
Calabash Gourds	321
Calabash Pipes	321

	Page
Sugar Beets Ready........	339
Sugar Beet Field..........	339
Raspberry, Black	357
Kharkof Wheat	375
Cowpea Seed	393
Barley, Smut of...........	411
Farmer in His Field........	423
Native Pasture	423
Corn, Select Ears of.......	431
Seed Corn Saved..........	449
Wheat, Smut of...........	467
Soil, Cracked Surface......	485
Soil, Slicing Cracked.......	485
Prickly Pear Crops........	503
Currants	521
Ramie	539
Seed Ears of Corn.........	557
Trial Grounds	575
Bulb Trial Grounds.......	575
Millet	593
Grama Grass	593
Soy Bean Seeds............	627
Soy Bean Pods............	645
Mushrooms	663

FIELD AND GARDEN PRODUCTS

PART I

GRASS AND HAY

TIMOTHY.

GRASSES are so common, growing everywhere in meadows and waste places, upon hillsides and plains, covering as with a verdant carpet the bare places of the earth with their myriad hosts of individual plants, that the beholder is apt to forget their vast significance in the economy of nature and that they constitute the greatest of our agricultural resources and form the very foundation upon which rests much of our agricultural wealth and prosperity. According to estimates of the Division of Statistics the hay crop of 1910 alone amounted to 60,978,000 tons, valued at $747,769,000, exceeding the total value of the wheat crop. In addition to this vast quantity of hay, which would barely suffice to carry through the year about 17,000,000 milch cows owned in the United States, enough pasturage, fodder and green forage were supplied to feed nearly 40,000,000 sheep, over 30,000,000 cattle, 15,000,000 horses and about 2,000,000 mules. A very conservative estimate places the total annual value of the grass and forage crops of this country at considerable more than a billion dollars ($1,000,000,000). (Dept. Agr. Y. B. 1910.)

In the United States and Canada there are many climates, kinds of soil, geological formations, degrees of aridity and moisture. It must be apparent that one species of grass can not be equally well adapted to growth in all of this extensive land; yet hardly a dozen species of grasses have been successfully introduced into American agriculture. True it is that this number, together with a number of local native varieties, answers with a tolerable degree of satisfaction the wants of quite an extensive portion of the country, chiefly the northern and cooler regions. But it is well known that in other localities the same kinds of grasses do not succeed equally well and one of the most important problems for those regions is to obtain such kinds as shall be thoroughly adapted to their peculiarities of climate and soil. The solution of this question is now in progress and is largely a matter of experiment and observation. The grasses now in cultivation were once wild grasses, and are still such in their native homes. Among the great nations of the world the United

States was the first to give official recognition to the importance of these crops by establishing in the Department of Agriculture a Division of Agrostology, especially devoted to work out systematically all grass problems.

No other region has so large a number of useful grasses and forage plants as the United States and Canada. There are within the United States alone no less than 60 native species of clover, 70 of blue grasses, 25 of gramas and curly mesquite grasses which have produced more beef and mutton than all the cultivated hay grasses put together, 90 lupines, 20 wild beans, 40 vetches and an equal number of forage beggar weeds, 20 kinds of wild rye, 30 kinds of brome grasses, besides meadow, pasture, woodland and swamp grasses without number, each kind adapted to a particular soil or climate and to some special use. Among the leading grasses are the following:

Timothy.—This grass, botanically known as *Phleum pratense,* is supposed to have been introduced from Europe, but the earliest account of its culture is that given by Jared Elliot (Special Bul. U. S. Dept. Agr. 1889), who says it was found by a Mr. Timothy Herd in a swamp in New Hampshire, and that he began its cultivation. As it was found to be a valuable grass, its cultivation soon spread, and it was originally known as "Herd's grass." It was not introduced into cultivation in England until some fifty years later. It is very probable that the specimens found by Mr. Herd were of native growth, for it is believed to be native in the White Mountains, in the Rocky Mountains, in Alaska and in Labrador. It is also a native of Europe.

Timothy thrives best on moist, loamy soil of medium tenacity, and is not suited to light, sandy, or gravelly soils. Under favorable circumstances and with good treatment it yields very large crops, often four tons to the acre. One writer states that he has known whole fields in Missouri grow to the height of 5 or 6 feet, the soil, a pulverized clay, being particularly suited to this grass. He also states that he has known fields of this grass to be highly productive for thirteen years in succession, though that was a rare exception, of course.

Farmers should not lose sight of the fact that the roots do not extend widely, and that much of its vitality depends on the thickened bulb-like base of the stem; therefore there is danger that, if mowed too late in the season so that the bulbs and roots are left unprotected from the weather, they may suffer from the action of frost, being sometimes lifted out of the ground from this cause. Timothy is an exhaustive crop, the roots not penetrating deep enough to obtain nourishment from the subsoil. Feeding off with stock lays the crown of the plants bare, which, being of a bulbous nature, are easily injured by exposure. When, however, the aftermath is very abundant, Timothy meadows may be pastured sparingly in the fall to reduce the heavy growth of rowan that sometimes accumulates so as to interfere with the mower; but in no case should sheep be allowed upon it, as they are very apt to nip off the crown of the plant and thus destroy it. In order to keep up the productiveness of a Timothy

meadow, a good top-dressing of stable manure should be applied and evenly spread in the fall. This will protect the roots and cause a much thicker and stronger growth. Timothy is often sown with clover in different proportions, and under some circumstances this is a judicious practice. But the more general practice is to have the Timothy meadows free from other plants, and to sow about 12 pounds of seed to the acre.—(Special Bul. Dept. Agr. 1889.)

In the great majority of cases the real cause of the success or failure of the timothy field lies in the treatment it receives after it has been seeded down. As a rule, it is not a difficult matter to get a good stand of grass. The trouble is in so handling the field as to get good returns and still keep the sod in a healthy, growing condition. —(Y. B. 1896.)

In 1889 seeds of selected stock or plants of timothy were gathered and in 1890 a few hundred of these seeds were planted in good soil in Minnesota. Each seed was given more than one square foot of ground in which the resulting plant could spread. In selecting these seeds the effort was to secure a foundation stock of plants with some distinguishing mark, that any improvements which might be made would be on plants easily recognized as different from ordinary timothy, of which there is only one species or variety in common use in America. It had been observed that the anthers of timothy at the time it is in the "blue bloom" vary from light straw color to dark blue. Plants representing the two extremes were marked when in bloom and when ripe the seeds were saved, the intention being to fit the colors as the distinguishing marks of two varieties. The rich soil and ample room caused the plants to make unusually strong growth, and a number of them retained the colors sought to be perpetuated. But this rich feeding forced the plants into a much stronger growth than occurs when crowded together in pasture or meadow. When headed out the second year, the plants then being 15 months old, each one had spread by stooling to ten inches or less in diameter, some much more than others. Some had longer heads, were taller, had longer radicle leaves, and were apparently much stronger and more desirable plants than others. Eight of the 324 plants developed some of the spikelets into marked branches. As nearly all the spikes, twenty to fifty, on each plant showing this variation had the branches, it is safe to assume that this feature can be made a fixed character by selection in a few to several years. These branches are useful mainly as a mark to go along with other intrinsic qualities, but they have a direct use in making the yield of seed greater. It would seem easy to continue or fix this characteristic by selection, and at the same time select to get plants better adapted to the various purposes for which timothy is grown. Investigators were able from this first generation of plants to choose those having large size, long stem and radicle leaves, great spreading or stooling habit, tall, strong, long, heavy bearing "heads" or spikes.

In climates subject to drouth all grasses that do not send out root-stocks underground, but spread only by stooling, do not make a continuous sod, but grow in bunches. The hay and pasture is less

in quantity and coarser in quality than if the blades and culms grew close and fine. In North Dakota there were seen timothy plants which had the bulb so modified that but little further change would produce underground root-stalks. Such plants would be even better foundation stock to start with than that first used in the work above mentioned. This report of progress is here given to illustrate the possibilities in this line of field crop experiments rather than to report finished results. Heads of barbed timothy are observed at very rare intervals in fields. The variation in timothy plants is even more than is observed between the scrubbiest stalk of corn and the stalk which grows tall and produces one or more large ears. The same may be said of other grasses and clovers.—(Minn. Bul. 20.)

In an experiment at Cornell the question was the subsequent influence of fertilizers in the production of timothy hay. The increase or decrease in yield of oats enters into the final problem. Two circumstances conspired to make the fertilizers less effective probably than normally in increasing the yield of oats, namely, the fertilizers were applied in the previous year and the seasonal conditions were favorable to a high yield of oats upon the untreated plats. The oat crop is known as a weather crop, that is to say, the crop is sensitive to the temperature and moisture conditions during the growing season, and if these are just right the soil is relatively less important. The residual influence of stable manure was quite marked upon the timothy hay, although it did not greatly increase the yield of oats. In no case did the increase in the yield of oats pay for the cost of the fertilizer applied, and on two plats where only mineral fertilizers were applied there was a decrease in yield.

After the removal of oats in 1904 nothing was done to the plats until April 5th, when each plat was fertilized as indicated in the table on page 39 except Plat 728, which received all fertilizers designated except "Niterlime." Plats 731 and 732, which had received 10 and 20 tons of stable manure respectively in 1903 were left untreated in 1905. On July 7, 1905, the timothy was mown and on July 12, 1905, the hay was weighed. The following table gives the yields of hay per acre, the increased yield of hay due to treatment, total value of the increase, and the net gain or loss from fertilizers. The total value of the increase is obtained by multiplying the increase in yield in tons by $10.60. This, according to the United States Department of Agriculture, is the average December farm price of hay in New York State for the ten years ending 1903.

Upon timothy the influence of nitrogen was most marked as shown both in the growing crops and in the yield of hay. The results are striking and unmistakable. The average yield of hay on eight plats receiving no fertilizer was at the rate of 2,160 pounds per acre; on three plats receiving only mineral fertilizers 2,890 pounds; on eight plats receiving nitrogen as nitrate of soda 4,676 pounds; and on two plats receiving nitrogen in stable manure 4,805 pounds. An apparent increase in yield of 10.3 bushels of oats and 4,137 pounds of timothy hay was obtained from two applications of 320 pounds of nitrate of soda, 320 pounds of acid phosphate and 80

Plat No.	Treatment	Yield of hay per acre. Pounds.	Increase in yield of hay. Pounds.	Total value of increase.	Net gain or loss (-) from fertilizers.
711	No treatment	1,910			
712	320 lbs. Acid Phosphate	2,680	607	$3.21	$1.61
713	80 lbs. Muriate Potash	3,190	954	5.05	3.45
714	No treatment	2,400			
715	160 lbs. Nitrate of Soda	3,550	1,216	6.44	2.84
716	320 lbs. Acid Phosphate 160 lbs. Nitrate Soda	3,840	1,573	8.34	3.14
717	No treatment	2,200			
718	320 lbs. Acid Phosphate 80 lbs. Muriate Potash	2,800	510	2.70	—.50
719	160 lbs. Nitrate Soda 80 lbs. Muriate Potash	4,280	1,900	10.07	4.87
720	No treatment	2,470			
721	160 lbs. Nitrate Soda 80 lbs. Muriate Potash 320 lbs. Acid Phosphate	4,590	1,877	9.95	3.15
722	160 lbs. Nitrate Soda 80 lbs. Muriate Potash 640 lbs. Acid Phosphate	4,350	1,394	7.39	—1.01
723	No treatment	3,200			
724	320 lbs. Nitrate Soda 80 lbs. Muriate Potash 640 lbs. Acid Phosphate	5,880	3,044	16.13	4.13
725	320 lbs. Nitrate Soda 80 lbs. Muriate Potash 320 lbs. Acid Phosphate	6,610	4,137	21.93	11.53
726	No treatment	2,110			
727	160 lbs. Nitrate Soda 80 lbs. Muriate Potash 320 lbs. Acid Phosphate	4,310	2,380	12.61	5.81
728	160 lbs. "Niterlime" 80 lbs. Muriate Potash 320 lbs. Acid Phosphate	2,470	720	3.82	
729	No treatment	1,570			
730	No treatment	1,420			
731	10 tons of manure	4,090	2,595	13.75	13.75
732	20 tons of manure	5,520	4,025	21.33	21.33

pounds of muriate of potash. A single application of ten tons of stable manure produced an apparent increase of 5.3 bushels of oats and 2,595 pounds of hay; twenty tons produced an apparent increase of 11.2 bushels of oats and 4,025 pounds of hay per acre. Where stable manure was applied a material proportion of the hay consisted of red and alsike clover due to seed in the manure. If stable manure can be applied at fifty cents per ton, the net gain from the use of ten tons was $10.55 and from twenty tons $15.14. While a marked increase of hay was obtained from the use of fertilizers containing nitrogen, the small increase in the yield of oats left only a small net gain and in some instances a net loss from two applications. When the experiment is studied in detail it appears that the proportion of nitrogen to phosphoric acid should have been greater in order to get the most profitable returns. When muriate of potash was applied either alone or with nitrate of soda there was a net gain.—(Cornell E. S. B. 232.)

Too often the only attention the farmer gives to the timothy field after seeding it is to take off whatever crop of seed or hay there might be and then to allow the stock to run at will over the field during the remainder of the year. As the land is usually very smooth and it is possible to run the mower very low, the field is often literally shaved close to the ground. Of course, such treatment results in a very short-lived meadow, which would not pay, and timothy growing is often abandoned, at least for a time. This was the custom and these the results of thousands of attempts to grow timothy on the prairies of Kansas, Nebraska, the Dakotas, and Minnesota.

Seeding.—The methods of seeding down to timothy in practice among farmers and stock raisers vary widely according to the peculiarities of the different regions. Experience has long since shown that what will succeed in one way may fail in another. There are, however, certain features of timothy growing to which everyone must give close attention if he would secure the best results. Timothy is a surface feeder, and hence the soil should be prepared in such a way as to concentrate an abundance of plant food near the surface and to allow the roots to penetrate to as great a depth as possible. One of the most common practices is to begin at least a year before seeding to the grass and put the field into some crop which will allow the land to be given a deep, late plowing, and a heavy coating of manure. If the land has been kept clean, it will usually be in good condition for fall sowing, if the season is favorable. If not, it may be further enriched, fall plowed if necessary, and seeded the next spring. It has been found that while the soil should be mellow down to a good depth, yet it should not be too loose, or it dries out too readily, and the timothy will not form a good sod.—(Dept. Agr. Y. B. 1896.)

There is no more favorable time to seed timothy or other grasses than in July, August or early September. To be successful, clean, well compacted and moist seedbeds are essential. Under such conditions no nurse crop is needed. A full crop of hay may be expected the following season. Fifteen pounds of timothy may be

counted a full seeding when used alone. When clover is used with the timothy, six to eight pounds of the latter, seven pounds of red clover and three pounds of alsike clover have been found satisfactory. Unless seeded during freezing weather when the ground is cracked open with frost, the seed should be covered with a light harrow or weeder. When seeded with wheat or oats it can be distributed through the grass seeding attachment of the grain drill and dropped in front of the drill hoes.—(Dept. Agr. Y. B. 1896.)

Harvesting.—Many experiment stations have tested the value of timothy cut at different stages of growth. Briefly summarized these results show that the total dry matter increases until the seed is close to maturity; that the total protein and fat, as well as the digestibility of the different nutrients decrease slightly after timothy passes full bloom; that the fiber and nitrogen-free extract increase during this period. All things considered timothy may safely be left until shortly after the blossoms have fallen, but not later than when the seed is in the dough. Comparatively late harvesting is favorable to rapid curing and consequently lessens the danger of loss from rain, with the alternate dissolving of soluble feed elements and bleaching in the sun, so destructive to quality and palatability. With good weather and the use of the hay tedder, there is little difficulty in curing and storing timothy in the barn or stack the day it is cut. If weather is settled, some time is saved by mowing it late in the afternoon before.

Yield.—In tests timothy led all other grasses in yield per acre. In 1905, the yield of hay was 2.92 tons per acre; in 1906, 2.62 tons; in 1907, 3.60 tons. The test plots were plowed up in 1908 and new seedings of all the different grasses tested were made July 1, 1909. In July, 1910, the new seeding of timothy gave a yield of 4.85 tons per acre of thoroughly cured hay. The four-year average yield is 3.497 tons per acre.—(Ohio E. S. B. 225.)

The Production of Seed.—As a seed producer timothy is usually to be depended upon. The yields seldom drop below five bushels per acre and frequently reach ten or twelve bushels. It can be harvested with the ordinary farm machinery. It is cut with a grain binder; at once put in shock "two by two," without caps, and allowed to cure about a week, when it may be threshed with a common grain separator, using special sieves. Timothy seed is usually much freer of weed seeds and generally has a higher percentage of vitality than clover or blue grass seed. This is perhaps because timothy seed is generally grown on comparatively new meadows and the seed crop is more certain.

Timothy seed is light gray in color, from 1-16 to 1-12 of an inch long, usually with the flowering glume and palet attached to the seed. The flowering glume or larger scale is marked by several more or less prominent nerves or veins; it is truncate at the top; the shorter scale or palet is also prominent. Many of the seeds are hulled in the process of cleaning; these seeds are more or less transparent. At the lower end of the hulled seed is a darker elongated area, the embryo. Timothy seed hulled or unhulled is easily recognized.

Impurities.—The chief impurities in timothy are buck horn, Rugel's plantain, curled dock, and in some samples pepper grass. The vitality tests of plump seed show germination lower than the standard. The percentage for plump seeds was 64, for shrunken seeds 27.7. One authority gives the percentage of impurities in sixteen samples of American grown seed at 7.25. The principal impurities found in timothy seed consist of pepper grass, dog fennel, black-eyed Susan, green foxtail, sour dock, field sorrel, rough cinquefoil, buckhorn, narrow-leaved plantain, rib-grass, common plaintain, red top and blue grass. The most common impurities found in seed offered for sale in Iowa will be found in the following table:

IMPURITIES IN 6 SAMPLES TIMOTHY. IOWA. PERCENTAGES BY WEIGHT.

No. of Sample	Total Per cent of Impurities	Red Clover (*Trifolium pratense*)	Crab-grass (*Panicum sanguinale*)	Buckhorn (*Plantago lanceolata*)	Rugel's Plantain (*Plantago Rugelii*)	Curled Dock (*Rumex crispus*)	Alsike Clover (*Trifolium hybridum*)	Other Weed Seeds	Sand and Dirt
1	16.99	4.					12.0		.99
2	1.47			.2	.05	.1		.4	.7
3	1.65	1.6							.05
4	.073		.063						.009
5	16.0	4.0					12.0		
6	6.97	.28			.146				

Average percentage 7.356. Excluding clovers 1.525.

Vitality.—The good timothy seed should have a vitality of 85 to 90 per cent. One authority records the average of American seed tests to be 80.1 per cent. The following table indicates the condition of the timothy seed:

GERMINATION OF TIMOTHY SEED TESTED OCTOBER, 1906.

Sample Number	Seeds Tested	Weight in Grams	Period Required for Germination												Total No. Germinating	Percentage of Germination for First Five Days	Percentage of Germination for Whole Period
			4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days	13 days	14 days	Over 14 days			
146	50 plump	.019				6		1		2					9		18
	50 shrunken	.019				1		6							7		14
152	50 plump	.020				8		17		1					26		52
	50 shrunken	.018				3		9		1			1		14		28
167	50 plump	.016				21		14					4	1	40		80
	50 shrunken	.016				3		36		1					40		80
179	50 plump	.021				31		6		1	1				39		78
	50 shrunken	.02				28		10		4	1				43		86
182	50 plump	.026				44		4		1					49		98
	50 shrunken	.022				26		13		4					43		96
189	50 plump	.02			11	15		4		2					32		64
	50 shrunken	.02			6	27		1							34		68
191	50 plump	.02			9	24		1							34		68
	50 shrunken	.016			9	24			1						34		68
193	50 plump	.021			14	12	1								27		54
	50 shrunken	.02			8	6		11					1		26		52

Total number plump seeds planted	400
Total number plump seeds germinating	256
Total number shrunken seeds planted	400
Total number shrunken seeds germinating	231
Percentage of plump seeds germinating	64
Percentage of shrunken seeds germinating	27.7

Only eight samples of timothy seed were tested as to germinative energy and, hence, no very general conclusions can be drawn. The average percentage of germination is only sixty-four. Though the standard of vitality in timothy seed of good quality is generally admitted to reach a percentage of not less than eighty-five.

In one sample of seed examined the following impurities were found: *Daucus Carota,* Wild Carrot; *Setaria glauea,* Yellow Foxtail; *Agropyron repens,* Couch-grass; *Amarantus retroflexus,* Rough Pigweed. Tumbleweed; *Cnicus arvensis,* Canada Thistle; *Cuscuta arvensis,* Dodder; *Cnicus altissimus,* Tall Thistle; *Cnicus lanceolatus,* Bull Thistle; *Rumex acetosella,* Sheep-sorrel; *Setaria viridis,* Green Foxtail; *Phleum pratense,* Timothy; *Plantago aristata,* Bracted Plaintain; *Plantago lanceolata,* Rib-grass; *Cichorium Intybus,* Chicory; *Lepidium apetalum,* Peppergrass; *Plantago Rugelii,* Rugel's Plantain; *panicum sanguinale,* Crab-grass; *Panicum capillare,* Old Witch Grass; *Rumex crispus,* Curled Dock. In this list of weed seeds attention may be briefly called to a few of the most important. The first of these is the Canada thistle occurring in thirty-two samples, quack grass in one sample, dodder in twelve samples. The farmer should refuse to purchase any seed containing the above seeds, no matter how low the price may be. In most cases they are difficult to remove from the seed and are hard to eradicate from a field. When once introduced, the Canada thistle by means of its long underground root stocks is enabled to defy extermination. When quack grass is introduced cultivation seems only to aggravate the difficulty. As for dodder it can be eliminated only by sowing seed entirely free from this weed.—(Iowa E. S. B. 88.)

The hay made from timothy is comparatively coarse and strawy with few leaves, but the character of its growth is such that it may be readily cured. The hay is, therefore, perhaps more certain to be free from dust than that from most grasses. It is therefore looked upon as the standard of excellence, and usually sells for a higher price than any other hay in the market. It requires a deep, retentive loam for its best growth. On such loams, with liberal top-dressing either with manures or fertilizers supplying abundance of nitrogen, it may prove quite persistent; but on the lighter soils and under less generous treatment it is likely to give way to inferior species within a comparatively short time. As previously said, at the surface of the ground on a timothy plant which is mature will be found a considerable number of pointed and rather small solid bulbs. If these be fed off, or if the mowings be too much trampled by heavy animals, which doubtless crushes and bruises the bulbs to a considerable extent, the timothy will be seriously weakened. It is not, therefore, well adapted to grazing, and great precaution should be used in pasturing mowings in which it is the principal species.

Whenever the soil is abundantly supplied with manure or fertilizers which supply nitrogen in relatively large amounts, timothy will be found relatively abundant in the mowing, unless the soil be sour. If it be sour, the red-top will predominate, while there will be little or no clover. If, then, it be desired to produce first-class

timothy hay for sale, the farmer should make sure that his soil is not sour; and if found to be so, he must apply lime. On soils which are not sour, heavy applications of barnyard manure bring the land into good condition for timothy; and if it be desired to produce market hay, it will usually be best not to use potash largely in connection with the manure for the crops preceding the grass. For market hay, heavy applications of nitrogen manures or fertilizers and relatively light applications of materials containing either potash or phosphoric acid should be the rule.—(Mass. E. S. B. 134, 1910.)

Timothy is more generally cultivated in the United States as a whole, and in Canada, than any other grass. Indeed, probably more than all other grasses combined. It is adapted to a great variety of soils, though it does best upon rich, moist loams and clays. It is distinctly a grass for hay rather than pasture. It may be used in pasture mixtures for early or temporary pasturage, but it will soon give place to the better sod-forming grasses, as it does not take kindly to close grazing and tramping. As a meadow grass, however, it stands at the head.

Rotation.—Timothy is grown by many farmers in a four or five year rotation, being seeded with clover in wheat or oats. The first year of meadow, clover is the principal crop; the second year, timothy predominates. Near good city markets it is often grown year after year without reference to rotation, good yields being maintained by annual dressings of manure or other fertilizers. Timothy, like other sods, is valuable in maintaining the humus supply of the soil. Such sods are usually plowed for corn. Old sods are likely to be infested with insect pests and should be plowed if possible during freezing weather.

Popularity.—The popularity of timothy among farmers is easily accounted for. It lies in its good yield; in its palatability; in the ease and cheapness with which it is harvested; in the great demand at good prices for timothy hay; in the moderate expense of seeding an acre to timothy; in the good germination of seed and the relative certainty of securing a stand, and in its longevity when properly cared for. With annual dressings of manure or, in the absence of manure, of nitrate of soda supplemented with acid phosphate and muriate of potash, and, when needed, lime, timothy may be made to give good yields of hay indefinitely. Ordinarily this would not be desirable, but under certain conditions it is admissible.

Disadvantages.—In common with all the grasses timothy is lacking in ability to utilize the nitrogen of the atmosphere through the aid of such micro-organisms as co-operate with clover and other legumes, and is consequently a much more exhaustive crop on land than clover. While timothy cannot take the place of clover in a rotation, it should be recognized that the grasses leave crop residues in the way of sods of great value in maintaining the supply of humus. In so far as furnishing a crop of aftermath is concerned, timothy can not be counted upon to do very much during an average season. Only in case of exceptional rainfall during July and August

may a second crop worth harvesting be expected.—(Ohio E. S. B. 225.)

The soil where the timothy seed was sown was unfavorable for the growth of grasses. The grass grew well, however, and gave two crops during the season. The heads appeared July 18th and the crop was harvested August 5th. Before the end of September the timothy had again headed out. Because of the poor quality of soil this second crop was not harvested.—(U. Mich. Sub-Sta. B. 20.)

Timothy is rarely successful in any part of the Gulf States. It makes one good cutting in the spring after it is sown, but the long summer weakens the bulb-like roots so that but few plants survive until the next year.—(Dept. Agr. Div. Agros. B. 15.)

In conclusion it may be said concerning timothy that no other grass stands in such high favor as does this. It is highly productive, stands drouth well, and is not subject to winter-killing. There is a decreased yield from year to year, and it is found advisable to turn old fields under. Unless it is mixed with other grasses it is usually best not to keep a timothy meadow longer than three years. It has been stated however that there are upland meadows in Nebraska, for instance, which have been in constant use for fifteen years or more, and in that time have not failed to yield paying crops. In most regions of the United States and Canada, however, the timothy meadow "runs out" and is replaced by bluegrass. Pastures and meadows have been seen in Wisconsin that have been in constant use for fifteen years where considerable timothy could be found. With the timothy however, there was much bluegrass and clover. Timothy is often used in reclaiming worn-out native meadows and pastures, and with proper treatment very good results are obtained. It seldom yields well in pastures, however, for more than two or three years in succession unless the land is very rich and moist. It is, therefore, considered the best plan to sow the bluegrass with the timothy, and by the time the latter is pastured out the former will have occupied the land. Sowing on native turf is usually done in early spring. The seed is sown broadcast, and then the ground is gone over thoroughly with a heavy harrow. Native meadows on low, rich soil, that have become thin from continuous close cutting, may be very materially strengthened by the addition of a little timothy in this manner, as is known from experience in mid-western States generally.

In spite of the early failures, timothy is today one of the most valuable of all the meadow grasses grown in the northern Mississippi and Missouri valleys. As stated elsewhere, opinions differ as to when timothy should be cut. Many farmers wait until the seeds are in the "dough" stage; some even wait longer. The farmer who waits until the seed is ripening lacks thrift. It is far better to cut just before the timothy is in bloom or during full bloom. If cut before it blooms it is much more difficult to cure. It cures better if cut just after the blossoms fall. The best hay is obtained by cutting during full bloom, or when the blossoms fall. The feeding qualities are best at full bloom, but most farmers prefer to cut a little

later, as the pollen makes the hay dusty, which is avoided by waiting. It sometimes happens that, on account of lack of moisture, the first growth is light and abundant rains in June or July may cause a strong second growth to spring up, which will not be in its prime until the first has reached an advanced stage of development. In such cases it would be more profitable to cut late, provided the proper precautions are observed as to the condition in which the soil should be left. There is a growing sentiment in favor of cutting timothy with the self-binder for hay as well as for seed, and the practice has much to commend it. With right treatment the hay cures well, is much more easily handled and fed, and can be stored in a more limited space than when cut in the ordinary way.

Timothy hay may be decidedly improved by growing a small amount of clover along with it, nor is bluegrass mixture objectionable, except where present the grass must be cut early. Timothy can not be pastured when the soil is dry, as stock is very liable to injure the bulbs, but in low meadows it stands grazing fairly well in the spring, but cattle should not be allowed to graze on it in the fall. If timothy is to be used for grazing purposes it should be in a meadow containing bluegrass, redtop, timothy or clover. The clover readily perpetuates itself and helps the timothy, in that the soil is less compact.—(Iowa B. 56.)

Price of Hay for Forty Years.—The price received for hay is the governing factor in determining the profits in growing hay. As shown by the average farm value of hay per ton for the first five-year period of the forty years from 1865 to 1905 was $10.61 for the United States and $8.75 for the ten leading timothy-hay-producing States. The highest five-year period for both groups was from 1870 to 1875. These prices have not been equaled since that time, although the farm value since 1900 is higher than it has been since 1885. The average farm value per ton for the forty years was $9.30 for the United States, as compared with $8.58 for the ten timothy States.

Timothy is often said to be "hard" on the soil. This is because neither timothy nor any other grass can add any plant food to the soil in the manner that the legumes do, but must get all of its food from the soil; and it is therefore much more exhaustive of the available plant food in the soil than clover.

There is quite a difference in the amount of plant food contained in different kinds of hay plants. For example, one ton of timothy hay contains, on an average, 20 pounds of nitrogen, 10 pounds of phosphorus, and 28 pounds of potassium. If bought in the form of a commercial fertilizer, nitrogen is worth 20 cents a pound and the other two elements are valued at 5 cents each per pound. On this basis the fertilizing value of a ton of timothy hay will amount to $5.90, or $6 in round numbers. One ton of clover hay contains, on an average, 40 pounds of nitrogen, 8 pounds of phosphorus, and 40 pounds of potassium, which makes its fertilizing value amount to $10.40. According to these figures it would seem that there is less loss of plant food in growing timothy than when

clover is grown. However, such is not the case, for clover and all other leguminous plants store up nitrogen in the soil. This class of plants is supplied with a certain kind of bacteria, which live in the tubercles on their roots. These bacteria have the power of taking free nitrogen from the air and making it available as food for the growing plant. Much of the nitrogen thus secured is left in the soil by the decay of the tubercles, roots, stems, and fallen leaves of the legumes, to the great benefit of succeeding crops.

When a ton of clover is removed from the soil, from one-fourth to three-fourths as much nitrogen is left in the roots and crowns and in the fallen leaves and stems left on the ground as is removed in the hay. As a greater part of this nitrogen came from the air, it is perfectly fair and proper when considering the loss of plant food in growing a crop of clover to disregard or deduct it from the total fertilizing value of the hay. When comparing the loss of fertilizing elements of clover and timothy, there is a difference of about $3 a ton in favor of clover hay. Just how much of this amount should be charged to the hay when considering the profit from selling hay can not be stated definitely, for the kind of soil, system of rotation used, and type of farming play important parts in keeping up the crop-producing power of the soil.—(F. B. 362.)

In order to grow timothy hay successfully year after year, the farmer must also grow some legume crop in the rotation for either hay or pasture or as a green-manuring crop, which aids in keeping up the crop-producing power of the land. When considering the profit from hay growing the farmer must consider not only the cost of production, or growing, curing, baling, and marketing, but to a certain extent the value of the fertilizing elements which the crop removes from the soil.—(F. B. 362.)

Suggestions on Fertilizing for Timothy.—It is difficult to make definite recommendations in regard to the use of fertilizers for grass lands. It is definitely known that chemical fertilizers very often, it may be said usually, exert a marked influence on crops, but it is almost impossible to say just what fertilizers or how much of them should be used in a given case of grass land with the assurance that the results will be favorable. Every farmer must experiment with his own land, using the experience of other farmers and investigators as suggestions only.

Of the fertilizing elements usually applied as plant food, nitrogen seems to be the most potent factor in increasing the yield of timothy and related grasses. Unlike the clovers and other leguminous plants, timothy is incapable of acquiring any of its nitrogen from the air, but must depend on that supplied to the soil. The best evidence shows that it requires for its full development a liberal supply of nitrogen throughout the growing period. This has been clearly demonstrated. Nitrogen seems to attain its greatest efficiency, however, when judiciously combined with the mineral elements of plant food, potash and phosphoric acid. In the experiments on Dunkirk clay loam the best financial returns were obtained when farm manure was applied at the rate of 20 tons per acre. Similar results

were obtained in West Virginia where annual applications of farm manure were made for six years at the rate of 10 to 15 tons per acre. In the latter case, applications were made in the fall as a top-dressing and in the spring the land was harrowed thoroughly and rolled. In addition to giving the best immediate returns, the farm manure improved the physical condition of the soil. The meadow produced hay during the six years of the test to the value of more than $36 per acre, after paying for the manure applied, while the land at the close of the test was more valuable than at the beginning. The lasting effects or the value of farm manure to later crops should always be considered when comparing it with the value of commercial fertilizers. The best financial returns may be expected from the use of farm manure when the latter can be purchased for 50 cents a load. This estimate does not include the effect on subsequent crops to which a value should be assigned.

For the farmer who wishes to raise a large proportion of hay on this type of soil, an eight-year rotation may be suggested: wheat one year, hay five years, corn one year, and oats one year. The farm manure should be incorporated with the soil previous to seeding with timothy and wheat in the fall. In the following spring a mixture of red and alsike clover may be seeded. Annual applications of farm manure should then be made for the grass crops, the applications being given as top-dressings in the fall and harrowed in the following spring. It might be advisable in some cases to make top-dressings of manure once in two years, in which case larger applications should be made.

When farm manure can be produced in sufficient quantity the use of commercial fertilizers is not necessary. But the farmer often finds it advantageous to reserve a large part of the farm manure for other than his grass crops, in which case commercial fertilizers may be substituted wholly or in part if used judiciously. When the supply of farm manure is limited it would be advisable to use smaller applications in the fall than stated above, supplementing this in the early spring by small applications of the commercial fertilizers. Of the commercial fertilizers, the most satisfactory returns were obtained on Dunkirk clay loam by the use of a complete fertilizer, consisting of 320 pounds of nitrate of soda, 320 pounds of acid phosphate, and 80 pounds of muriate of potash, per acre. The results indicate that a still smaller proportion of acid phosphate would have been more economical. The following mixture, therefore, is suggested: 200 pounds of nitrate of soda, 100 pounds of acid phosphate, and 50 pounds of muriate of potash, per acre. It would be best for the farmer to determine by actual field tests the quantity most desirable for his land. As the mixed fertilizers found on the market usually do not contain the elements in the proportion suggested by the above formula, it would be best for the farmer to buy the separate ingredients and mix them himself. The ingredients called for are usually sold under guaranty by the fertilizer companies and vary but little from the following composition: Nitrate of soda, 15 to 16 percent nitrogen; acid phosphate, 12 to 14 percent available phosphoric

acid; muriate of potash, 50 per cent potash. The use of lime was found not to increase the yield of timothy. On the other hand, timothy does not thrive on sour or acid soils until the acidity is corrected by the use of lime or wood ashes. This fact has been clearly demonstrated in Rhode Island.—(Cornell B. 261.)

RED TOP.

This grass (*Agrostis alba-vulgaris*) is one of the most valuable to all husbandmen, both in Canada and the United States. It is a native, ranging across the northern portion of the continent, growing naturally in cold, wet soils. In cultivation it is the standard grass to grow in similar situations. There are a great number of forms or varieties which differ in height, leafage, and the manner of growth, so that great variability may be expected. Opinions differ widely in regard to its value, because of this diversity of forms. It is a perennial, provided with long creeping stems and underground runners, and is one of the best bottom grasses, bearing large numbers of fine root leaves. Because of this and its creeping habit of growth, it is one of the best grasses to use in mixtures with erect tufted species, such as orchard grass and timothy, filling in between the clumps and producing a continuous turf. The weight of the seed varies according to the quality, from 8 to 30 pounds to the bushel, averaging perhaps not more than 10 or 12. Mixtures of red top and alsike clover are largely used for low, wet meadow lands and pastures. The creeping habit of this grass makes it less liable to injury from trampling by stock than is the case with the tufted, bunchy grasses. —(U. S. Dept. Agr. F. B. 66.)

Many writers of the early part of this century do not speak favorably of *Agrostis alba* as a forage plant, although its cultivation began in 1761. Stebler and Schröter state that it was introduced into Ireland about the beginning of this century; Dr. Richardson pointed out its merit, and on his recommendation it came to be extensively cultivated in Great Britain. The cultivation of Fiorin commenced on the continent about 1840, where it was held in high esteem. Jessen, 1863, praises its qualities as a forage plant in Germany, but says it is difficult to harvest. In this country it has been cultivated for a long time. Flint says: "It was called simply English grass by Eliot, Dean and other early writers, and by the English, fine bent. Most of the grasses of this genus are known in England under the name of 'Bent Grass,' of which there are many species." Red top is a very variable species; there are included under it a number of well marked and distinct varieties, some of which have received distinct names.

It is sometimes though improperly called Herd's grass and has long been known to the farmers, and in its several forms is deemed valuable for permanent meadows and pastures, where the land is not too dry. On good soil it yields well and makes excellent hay. Some of the forms employed alone make, under favorable circumstances, the softest and finest turfs for lawns. Red top in this country is often sown on marshes too wet for some of the better grasses. It is not well

adapted to alternate husbandry, as it takes several years to become well established.

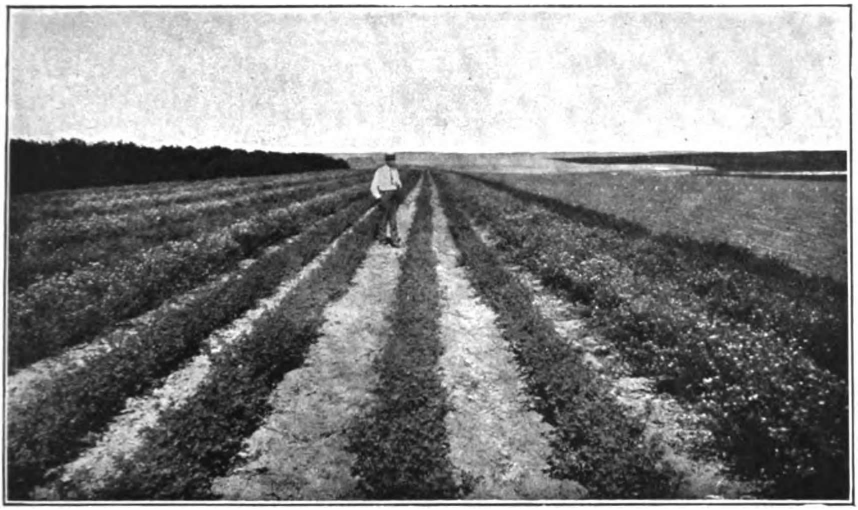
It makes a very resistant and leafy turf, which well withstands the tramping of stock. It grows well, also, as far south as Tennessee. Among the forms of low growth are two varieties which are unsurpassed, either in fineness or richness of color, for making lawns.—(Iowa Agr. Exp. Sta. B. 56.)

Red top has a nearly worldwide distribution, growing especially well in damp climates and on low, wet ground. Its chief value is as a pasture grass, although it is used for hay and also makes excellent lawns. Red top seed is largely raised in Illinois and is exported to all countries. The fact that the seed is home grown enables the dealers to furnish purer seed than is usually the case with the imported article. Two principal grades are sold, "Fancy silver" and seed in the chaff. The "Fancy silver" should have a high percentage of purity. As high as 90 per cent may be expected. In the other grade there is always a great deal of chaff, and 60 per cent is a fair standard. The principal impurities besides chaff are timothy, horesweed, Saint John's-wort and yarrow. It should yield from 10 to 20 bushels per acre of seed, and more has been obtained. The seed is a small, reddish grain inclosed in a silvery white, translucent glume. The glume is about one-fourth again as long as the grain and has a tuft of hair at the base, which is, however, often rubbed off in cleaning. The seed of this species is slightly larger than that either of creeping bent or of Rhode Island bent, but otherwise is indistinguishable except that the awns of Rhode Island bent, if not broken off, furnish a good characteristic for identification. The outer glumes of red top come off easily, and in chaffy samples will make from 30 to 60 per cent of the weight. In the "Fancy silver" grade the chaff has been blown out.—(U. S. Dept. Agr. Y. B. 1898.)

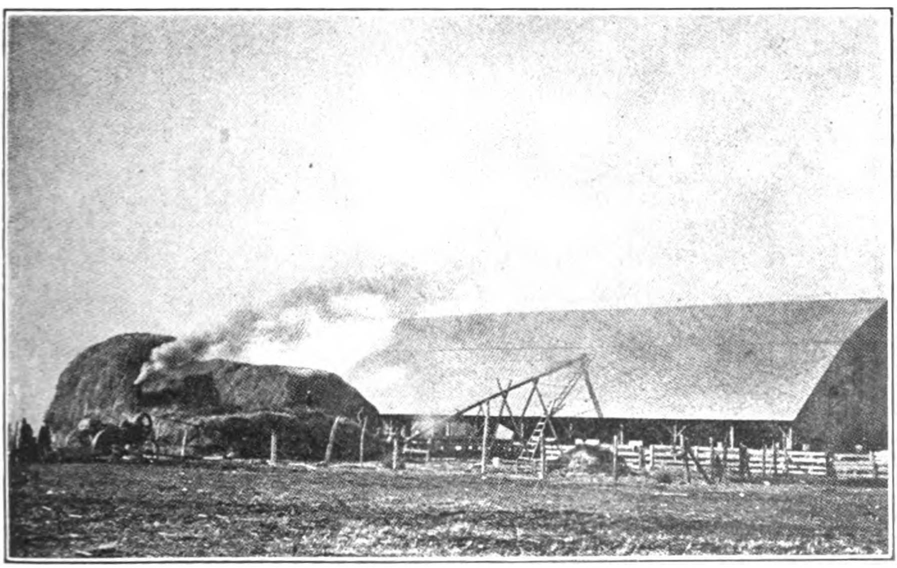
ALFALFA.

The accompanying illustrations indicate the general appearance of the plant. It may briefly be described as being a deep-rooted, long-lived herbaceous forage plant belonging to the botanical family *Leguminosæ,* or pod-bearing plants. Its flowers are violet, clover shaped, borne in compact oblong clusters. The pods are small, slightly hairy, and spirally coiled in two or three turns. The kidney-shaped seeds are about one-twelfth of an inch long, and several are contained in each pod. One of the most important characteristics of alfalfa is its long taproot, often extending 15 or more feet into the soil. This enables the plant to reach stores of plant food in the soil which can not be secured by the ordinary shallow-rooted field crops. This length is also of great importance in sections of limited rainfall, as by this means the plant is enabled to withstand extremes of drouth which would otherwise be fatal.

The wide distribution of alfalfa indicates a remarkable adaptability to various climates and conditions. So far as climate is concerned alfalfa can be grown in every State in the Union. It is, however, very exacting in the humid sections as to soil and treatment. It is grown below the sea level in southern California and at altitudes



Alfalfa in Cultivated Rows, Kansas 1908. Different Maturity for Seed.



Delivering Chopped Alfalfa into Barn by Pipe. Dept. of Agr.

exceeding 8,000 feet in Colorado. Under proper irrigation it yields abundant crops in the deserts of Arizona, which are among the hottest in the world. The hardy strains are able to withstand the severe winters of the North Central States. It is raised without irrigation in semi-arid sections where the rainfall is only 14 inches a year, and also in the Gulf States where the annual rainfall may amount to 65 inches. A rainfall of 36 inches a year is ample for this crop, and an amount in excess of this is usually a detriment. In moist climates the soil is frequently sour, and the clay soils especially are apt to be too poorly drained. In such a climate weeds and fungous diseases prove much more injurious than under less humid conditions. Although the adaptability of alfalfa is great, yet in the areas not perfectly suited to its successful production care is necessary to provide the very favorable conditions required by the young plants in order to overcome the natural drawbacks.

Soil.—A deep, fertile, well-drained soil rich in lime and reasonably free from weeds is necessary for alfalfa. The lack of any of these essentials is apt to be the cause of failure, especially in the Eastern and the Southern States, where alfalfa is at best produced with some difficulty. If the soil lacks depth the alfalfa plant is unable to utilize its deep-feeding root system and is less likely to withstand the inroads made by the surface-feeding weeds. The roots can, however, penetrate rather stiff clay soils, and even some of the soils underlaid with hardpan. Instances have been observed in the limestone sections of the Eastern and Southern States where alfalfa was growing successfully on soils underlaid at a depth of but 18 inches with limestone ledges. It is able through the nodule-forming bacteria within its roots to add nitrates to the soil and in this way increase its fertility. Since large yields of alfalfa draw on the soil rather heavily for the other elements of fertility, it usually requires the richest and best-drained soil the farm affords, and will bring returns to justify the use of this land. There is risk, however, in selecting bottom lands for alfalfa, on account of failure to drain and owing to the danger from weeds. In the East it is usually best to develop the fertility of some of the higher rolling land and seed this to alfalfa. West of the Mississippi River the soils are usually fertile enough for alfalfa without the use of any fertilizer. But even there the time will come when some attention will have to be paid to fertilization, as the best of soil will in time give way to the exactions of any crop.

In the East and South, however, they usually require some artificial treatment to bring them up to the proper degree of fertility before alfalfa can be safely planted. This result may be brought about by the plowing under of some green-manure crop, the application of commercial fertilizers, or the spreading of barnyard manure.

Manure for Alfalfa.—Well-rotted barnyard manure is usually the most satisfactory fertilizer for alfalfa. Fresh manure is apt to carry large numbers of weed seeds; therefore, if necessary to use it, the application should be made to the preceding crop. This will give time for the germinating weed seeds to be destroyed by the cultivation of the preceding crop or by the stirring of the ground incident

to the preparation of the seed bed for the alfalfa. Green-manure crops are especially efficient in increasing the humus content of the soil, and this is exactly what many soils require if alfalfa is to be raised upon them. In the South cowpeas, crimson clover, vetches, and even bur clover are successfully used. In the States farther north crimson clover, cowpeas, soy beans, and vetches may be utilized. It is usually best to follow the green-manure crop with some clean-culture crop before seeding the land to alfalfa, as the decaying vines induce acid conditions in the soil that are unfavorable to the alfalfa plants.—(F. B. 192.)

Commercial Fertilizers.—If barnyard manure is not available and if there is not time for the utilization of green-manure crops, it is necessary to apply commercial fertilizer to any soil that may be lacking in fertility. This fertilizer should be reasonably rich in phosphoric acid and potash, but may be poor in nitrogen. However, the kind and amount of fertilizer necessary vary greatly with the soil and section, and exact recommendations can not be made. In the humid sections of the country it is especially important to provide a well-drained soil for alfalfa. In the irrigated districts the problem of drainage to prevent or reduce the accumulation of alkali is often serious. In the regions of heavy rainfall natural drainage must be provided. It has been found that alfalfa requires much more complete drainage of the soil than do other field crops. Where the underdrains are unable to carry off the rainfall rapidly enough, it is sometimes the practice to backfurrow, leaving the dead furrows at intervals of a rod or less. This permits the water to run off quickly in the event of heavy rains. Alfalfa is often killed by overflows from streams. During its growing period it will not usually withstand more than twenty-four hours of complete submergence or more than forty-eight hours of partial overflow. During the dormant period of winter, however, fields have been known to remain under flowing water for two weeks without serious injury.

A Well-Limed Soil Essential.—No other forage crop requires as much lime in the soil as does alfalfa. It is apparently necessary that the soil acidity be neutralized by the lime and that there be also an excess for the actual use of the plant. In one test an analysis was made of the mineral constituents of certain crops. The percentage of lime in the alfalfa ash was 34.9, while red clover had but 20.6 per cent, and timothy had only 4.7 per cent. Throughout the East and South alfalfa is most easily produced on the limestone soils. Even these often require liming for the success of the alfalfa, as the rains tend to leach the lime out of the surface layers of the soil.

Weed-Free Soil.—Young alfalfa plants are very tender and apt to be killed by weeds during their early stages of growth. For this reason it is essential that the land be as free from weeds as possible. This condition can be brought about by raising some cultivated crop for two or three seasons previous to planting alfalfa. The same results can also be secured by seeding the land successively to crops, such as cowpeas, which naturally prevent the growth of weeds. If a weedy soil must be used, the land should be plowed several months

before the alfalfa is seeded and the successive crops of germinating weeds destroyed by frequent harrowing. Weeds are especially harmful to spring-seeded alfalfa, and for this reason spring seeding should be avoided and late summer or early autumn seeding practiced in all sections where this can be done.

Crops Which May Precede Alfalfa.—The time of year that any given crop may be harvested and the land prepared for alfalfa is an important factor in choosing the crop to precede alfalfa, which usually requires seeding at a certain definite time in any given locality. In sections where late summer seeding of alfalfa is possible the early-maturing truck crops, such as early potatoes, enable one crop to be secured that season and still allow time for the preparation of the land for alfalfa. In addition to this the clean culture given the truck crop will tend to rid the field of weeds and will make plowing unnecessary. The residual effect of the heavy fertilizer applications which must be made for the truck crop will usually suffice for the alfalfa. Except in the extreme North small-grain stubble can usually be worked up in time for late summer seeding. This is especially true of oats.

Clean-culture crops, such as corn in the North and cotton or tobacco in the South, are useful in ridding the land of weeds. As in the case of truck crops, a heavy application of manure may be given these crops and the culture given them will destroy any weeds that may have been introduced with the manure. It is usually impossible in the sections indicated to get such a crop as corn off the land in time for the late summer seeding of alfalfa. In such cases a green-manure crop, such as hairy vetch or common clover, may be seeded in the fall, cut for hay the following spring, and the stubble plowed in preparation for alfalfa.

Preparing the Seed Bed.—The tender nature of the young alfalfa plants requires that the soil be in excellent tilth at planting time. The seed bed should be fine on top but thoroughly settled. The young taproot of the alfalfa plant strikes down immediately and is apt to be seriously injured if it encounters a layer of loose dry soil at the bottom of the old furrow. As a general rule about six weeks are required for plowed land to settle enough for alfalfa seeding. It is sufficient, however, with many soils that they be disked instead of plowed. Less time is required for the disked land to settle and the operation is much less expensive than plowing.

It is important that the preparation be uniformly good, as the poorly prepared spots are apt to fail. These bare places form the centers from which weeds may spread and ultimately destroy the whole stand. Summer fallowing is often practiced in the semi-arid regions to conserve sufficient moisture for the germination of the seed at planting time. This method is also effective in any section for ridding the ground of weeds.

Preparation of Sandy Ground.—It is often difficult to establish alfalfa on soils that are so sandy that they drift when bare. The young unprotected alfalfa plants are very apt to be cut off by the drifting sand unless special precautions are taken. This danger may

be avoided by applying a light top-dressing of straw or coarse manure just after seeding. Another method is to drill the alfalfa into the high-cut stubble of cane, kafir, or millet; or the alfalfa may be seeded in a thin young stand of small grain, such as oats, which makes a rapid early growth and thus protects the seedling alfalfa plants.

Time of Seeding.—The time of seeding alfalfa varies in the different sections of the country, but late summer seeding is usually best in the East and South. The general principle underlying the time of seeding is to sow as far in advance as possible of what promises to be the most trying season for the young plants. Spring seeding is the rule in the irrigated and semi-arid sections of the West. It is also preferable in Minnesota, Wisconsin, and the Dakotas, where any but spring or early summer seeded stands are very apt to winterkill. Fall seeding is sometimes practiced in the extreme Southwest, and late spring seeding may be necessary at times in the Southern States when drought or other unfavorable conditions have prevented fall seeding.

The weeds of midsummer constitute the worst danger to the young stands of alfalfa in the humid sections of the country, except the extreme north, where this danger is exceeded by the danger of winterkilling. Wherever possible in the humid sections of the country late summer seeding should be practiced. The advantage of this time of seeding over that of either spring or fall is that an early-maturing crop may be removed in time for seeding, the weeds of midsummer are avoided, and ample time is given for the making of a strong growth to resist winterkilling and the heaving of the ground in the spring. The large growth of the plants possible during the early fall also enables them to make a rapid early growth the following spring. On this account the alfalfa is able to resist much better the inroads of weeds than if it had been seeded the previous fall or during the same spring. A fair yield of hay is secured the season after seeding, and in this way there is not the loss of the use of the land for a year, as is likely to be the case with spring or fall seeding.

Selection of Seed.—This is an important matter. The original source of the seed, its vitality, and its impurities should each receive consideration. Experiments indicate that it is not harmful to sow northern-grown seed in the South, but southern-grown seed should not be seeded in the Northern States on account of danger from winterkilling. It is usually desirable to secure samples from more than one source and test them as to germination and purity before purchasing. It is not a difficult undertaking to make a home test of the seed.—(Bu. Plt. Ind. B. 339.)

Home Testing.—It is difficult for one who is not accustomed to handling alfalfa seed to accurately determine its percentage of purity, especially the amount of dodder and other weed seeds present, but a general estimate of the quality of unadulterated seed can be formed on the basis of color. The percentage of seed that will grow can easily be determined by means of the simple tests.

Mix the seed thoroughly and count out 100 or 200 seeds just as they come, making no selection. Put them between a fold of cotton flannel or some similar cloth, taking care not to let the seeds touch one another. Lay the cloth on a plate, moisten it well, but do not saturate it, cover with another plate and keep at a temperature of about 70° F. Every day count and take out the sprouted seeds. In from four to six days all of the good seeds will have sprouted, and the percentage of seed that will grow is known.—(B. P. I. Bul. 97.)

Not only should alfalfa seed be of good quality and strong in vitality and germination, but it should be clean and free from foul weed seeds. It seems hardly necessary to enlarge on this point, yet many farmers are careless, much poor seed is sold and sown, and many costly failures result. Alfalfa seed costs so much, and the expense of a failure to get a stand is so great, that many farmers are discouraged by an unsuccessful trial, while others hesitate to make the venture. Those who are familiar with alfalfa seed can usually recognize seed of low vitality. Seed of good quality has a characteristic bright, clear color, while seed which has received injury from wetting or heating has a dull dead color, indicating its impaired vitality. Seed which is badly shrunken is also apt to contain a large percentage of seeds of low vitality which will not germinate and grow under ordinary soil conditions.

A good, simple and handy test is to use a cigar box; place several folds of wet paper in the bottom of the box, over it sprinkle the seed and cover with several folds of wet paper; close the box and set it in a favorably warm place. Examine the seed in four or five days and count the germinations, remoistening the paper if necessary. At the end of eight or ten days the test may be discontinued and the percentage of germination calculated. A large percentage of germination the first three to five days indicates a strong, vigorous seed, while a slow, weak germination indicates seed low in vitality, which may not germinate when planted except under the most favorable soil conditions. For the best seed the percentage of germination should be eighty-five per cent or more. A low percentage of germination, and fairly quick and strong, indicates a mixture of good and poor seed, and such seed may be sown, but more seed will be required per acre to insure a stand.

Carefully examine the seed for impurities, and if weed seeds are present the alfalfa should be carefully cleaned before seeding. The parasite dodder is now appearing quite extensively in alfalfa fields in some parts of the West. This is a most dangerous pest, and it is usually unsafe to sow seed infected with dodder, even after thorough cleaning; but dodder seed is only about one-half as large as alfalfa seed, and by careful cleaning, using a "dodder sieve," which will also remove many of the smaller alfalfa seeds, the dodder may be removed, leaving only the choice, plump, clean alfalfa seed to sow.

Amount of Seed to Sow.—The amount of alfalfa seed to sow will depend to some extent upon the quality and vitality of the seed. The general practice has been, and perhaps still is, to sow about

twenty pounds of seed per acre, but many of the oldest and most successful alfalfa growers are now using much less seed. Good stands have been reported from sowing as little as six pounds of good seed per acre. The seeding trials at the Kansas Experiment Station also prove that ten or twelve pounds of good seed per acre, sown in a well-prepared seed-bed, will produce an excellent stand of alfalfa. With alfalfa, as with clover, doubtless the season has much to do with securing a successful catch, but even in an unfavorable season it is possible, with an average amount of good seed sown at the right time in a properly prepared seed-bed, to secure a good stand of alfalfa.—(Kan. E. S. Bul. 155, 1908.)

Alfalfa seed is about the size of the seed of red clover, but is easily distinguished from it by its uniform light olive-green color, as contrasted with the purple and yellow of clover seed. Unlike red clover, it varies considerably in shape. The best grades of alfalfa seed contain comparatively few weed seeds. The low grades, however, which are mostly screenings, often carry large numbers of weed seeds, as was the case with one sample. This sample contained 6.8 per cent of weed seeds, or nearly 32,500 per pound, of which 5,490 were dodder.—(Bu. Plt. Ind. Bul. 97.)

Methods of Seeding.—The manner of seeding varies considerably in the different sections, but the various methods agree in that it is necessary for the seed to be covered and not sown on the surface of the ground, as is sometimes done with grasses and clovers. Alfalfa may be planted with a drill or seeded broadcast with a hand seeder or wheelbarrow seeder, or by hand. It is usually best to sow half the seed one way across the field and the other half at right angles to the line of the first sowing.

The depth of planting depends on the soil conditions. Covering from three-fourths to 1 inch deep is usually sufficient on clay soils, but an inch and a half is necessary on sandy soils or in the semiarid sections, where deep covering is required to insure sufficient moisture for the germination of the seed. When seeded broadcast, a light harrow, weeder, or brush is used to cover the seed. In case the soil is light it may be rolled, but this is not usually advisable, as the soil is more apt to become dried out before the plants can become established. A smaller quantity of seed is used when it is drilled. If a grain drill is used, the amount seeded may be regulated by the use of leather thongs to reduce the feed.

Rate of Seeding.—The quantity of seed required per acre is much greater in the humid sections than in the semiarid and irrigated sections of the country. In the West fair stands have been secured with as little as 1 to 5 pounds of seed per acre, but this has been under perfectly ideal conditions. Good stands from 5 pounds of seed to the acre are not unusual in the West. Twenty pounds per acre is the amount usually recommended, however, and even this must be increased where the danger from weeds is serious and it is necessary that the alfalfa plants cover the ground from the start to prevent the weeds from becoming established. A pound of ordinary alfalfa contains about 220,000 seeds. As there are 43,560

square feet in an acre, each pound seeded would give about 5 seeds to the square foot. At the rate of 20 pounds per acre each square foot would receive 100 seeds. Many of these fail to grow, and the young plants meet with many accidents. Counts in old alfalfa fields have shown from 1 to 6 plants per square foot, practically equal yields being secured from all. A year-old field in Virginia was found to contain 20 plants to the square foot.

The following recommendations as to the rate of seeding are made for the different sections of the country. Atlantic and Southern States, 24 to 28 pounds per acre; States east of the ninety-eighth meridian and west of the Appalachian Mountains, 20 to 24 pounds; semiarid sections of the Great Plains, from 5 to 15 pounds, depending on the average rainfall;, 15 pounds is commonly seeded in the irrigated sections by experienced growers.

Use of a Nurse Crop.—In the East and the South and in the semi-arid sections of the West a nurse crop usually proves disastrous to alfalfa, often resulting in the complete destruction of the stand. In sections where it can be used alfalfa usually succeeds in spite of the nurse crop rather than by reason of it. In the irrigated sections of the West a nurse crop is often used, the two crops beeing seeded together in the spring.

In the extreme Southwest barley is sometimes seeded with alfalfa in the fall. In the States bordering on Lake Michigan a half seeding of beardless barley is often a success as a nurse crop for alfalfa, but even in this section it is generally recommended that the alfalfa be seeded alone in midsummer. In sandy soils a very light seeding of small grain as a nurse crop is sometimes used to prevent the sand from blowing and injuring the young plants. In all cases the nurse crop, if ever used, should be cut as soon as it shows signs of injuring the alfalfa plants. Sometimes a successful stand may be secured in Ohio and neighboring States by seeding in corn at the last working. This method is apt to prove a failure in case of a dry season.

Inoculation for Alfalfa.—Throughout the western half of the United States the soil appears to be naturally supplied with the proper bacteria for the formation of the root tubercles. In the eastern part of the country, however, where the soil conditions are less favorable to the growth of these bacteria, it is nearly always necessary to supply them at the time of seeding. This inoculation may be supplied either by scattering soil from a successful alfalfa field or in the form of artificial cultures.

Inoculation by Soil Transfer.—Although possessed of some disadvantages, inoculation by means of soil from a successful alfalfa field will nearly always produce the desired results. It is essential that care be taken to avoid the introduction of seeds of noxious weeds or harmful plant diseases. The bulkiness of the 300 to 800 pounds of soil necessary for an acre makes it advisable to secure the soil from a field as near by as possible.

It has been found that soil from around the roots of the sweet clover (***Melilotus alba***) is quite as effective as alfalfa soil. In most

sections of the country this plant may be found growing wild in scattered clumps. In the South, where bur clover occurs, soil from around its roots may be used with good results. The soil may be mixed with the seed and sown with it. It may also be drilled or broadcasted separately. If broadcasted, the soil should be scattered on a cloudy day or toward evening and immediately harrowed in, as sunshine is harmful to the germs.

If the soil has to be freighted considerable distances, it is usually advisable to use but 200 or 300 pounds of soil per acre, but this should be mixed with several times its weight of ordinary soil to facilitate even scattering. If the soil is difficult to secure, it may be best to seed a very small area the first season, taking special precautions to have it thoroughly inoculated. This will then furnish an abundance of soil for inoculating a larger area the following season.

It can not be urged too strongly that inoculation is absolutely essential to the successful production of alfalfa. There are very few soils outside the alfalfa districts that do not require inoculation, and it may be taken as a general rule that all other soils must have the inoculation supplied in order to grow alfalfa successfully. A few soils, however, especially those upon which sweet clover grows naturally, seem able to produce successful stands without artificial inoculation. These, however, are the exception rather than the rule.

Inoculation by Pure Cultures.—The artificial cultures supplied by the United States Department of Agriculture are fully explained in the Farmers' Bulletin on the subject. These cultures are sent out in hermetically sealed tubes. The contents are mixed with clean water, and certain chemicals included with the outfit are added to the solution to form the food supply of the germs while they are multiplying. When the germs have increased sufficiently in number the solution becomes of a faint milky color. It is then applied to the seed. The seed should be dried in a shaded place and sown as soon as possible. The advantages of the artificial cultures lie in the greater ease of transportation and application as well as in the absence of the danger of introducing plant diseases or harmful weeds.

Inoculation produced by the cultures, in case it is successful, seems to be in every way as efficient as when the soil method is used. Fewer failures are reported in the case of the soil-transfer method, but the reason for this has not been definitely determined. It has been found that successes are more apt to follow inoculation with pure cultures if the seed is sown immediately after the seed has been dried after having been inoculated. There is some evidence accumulating to indicate that the germs in the pure cultures when they do survive are superior to those normally found in the alfalfa soil. It is suggested, therefore, that both the soil-transfer method and the artificial cultures be used.

Treatment the First Season.—If seeded in the late summer or early autumn, alfalfa will require no treatment that autumn unless a growth of more than 12 inches is made before cold weather. If this occurs, the plants should be clipped back so that they will go

into the winter with 8 or 10 inches of growth. In this condition they will be best able to withstand the winter and will be in excellent shape to renew their growth the following spring. The first cutting of hay should be secured in the late spring.

If, on the other hand, the seed has been sown in the late fall or in the spring, but little more than a clipping can be secured in the late spring or summer. This clipping should be made preferably when the basal shoots start and should be made 3 or 4 inches high, as the plants will be slow in recovering if cut too low. It may be necessary to cut at some other time than the ideal time indicated, as, for instance, when the weeds threaten to choke out the young plants, when the blossoms appear, or when the plants begin to turn yellow. Except in the latter case the clippings are usually left on the ground as a mulch. If the plants have turned yellow owing to some disease, the clippings should be raked up and removed. A top-dressing of nitrate of soda will sometimes invigorate the diseased plants. The same statements govern subsequent cuttings the first summer, except that the growth is usually too heavy to be left on the field.

Treatment the Second Season.—Ordinarily no treatment is required the second season, except to cut the hay when the plants are about one-tenth in bloom, or, better, when the new crown or basal shoots are starting. It is important to get the hay off the field as soon as possible, in order to allow the new growth to commence uniformly over the field. If the windrows or cocks are allowed to remain too long on the ground, the alfalfa plants will be smothered out and then bare spaces will form the centers from which weeds will spread.

No pasturing should be allowed during the first or second seasons, as the crowns have not become sufficiently well developed to withstand the effect of trampling. About three-fourths to a full crop may be expected the next season after late summer seeding in the humid regions. Nearly a full crop is usual the second season after spring seeding if the weeds of the first summer have not seriously injured the stand.

Treatment During Subsequent Seasons.—As long as an alfalfa field shows a perfect stand, with no tendency to run to weeds, it is not customary to give the field any special treatment. If the weeds begin to prove troublesome, it is advisable to disk the alfalfa after cutting. This process loosens up the soil and aerates it, which is decidedly advantageous to the alfalfa. The taproots of the alfalfa plants are not usually injured by this practice if the disks are set nearly straight, while the weeds are to a great extent destroyed. A spike-toothed harrow may follow the disk to level the ground.

In the East an implement known as an alfalfa renovator is meeting with success. It is a modification of a disk harrow with spike teeth on the disks. It is adapted to loosening up the ground and destroying the weeds without serious injury to the alfalfa. Many growers who have a large acreage of alfalfa disk their fields

each season. Disking, however, is apt to be destructive to the alfalfa in sections where the alfalfa does not thrive.

If there is a considerable growth of fall weeds or grasses these may be burned off the following spring before the alfalfa starts. The field should be burned before a strong wind to avoid injury to the alfalfa crowns. In sections where soils require liming, it is sometimes advantageous to make an application of lime either in the spring or after the first cutting. Slaked lime may be used, but ground unburned limestone is preferable, as this will not injure the alfalfa plants. A top-dressing of well-rotted or weed-free barnyard manure may be made during the early winter with advantage on most of the soils in the eastern half of the United States.

Drawbacks of Alfalfa.—Valuable as alfalfa is, it is not without its drawbacks and weak points. It is difficult to establish, especially in the Eastern States, where red clover is generally successful. The methods customary for the raising of red clover, however, do not apply to alfalfa and much has to be learned by experience as to the special requirements of the alfalfa plants.

On farms where the production of alfalfa is a side issue, the three or four cuttings of hay procured during the season are apt to come at a time when the normal work of the farm is directed along other lines. In such cases attention can not be given to the alfalfa work at the proper time without handicapping the major lines of farm work. Furthermore, when pastured by cattle and sheep, bloating is likely to occur, with the possibility of the loss of valuable animals. The seed is expensive and the cost of getting the ground in satisfactory condition is quite considerable, thus working a hardship if the stand is not a success, as is too often the case.

Need of Experimenting at First.—Perhaps no other crop requires such a variety of different treatments, depending upon the special locality in which it is grown, as alfalfa. For this reason early attempts are likely to be failures, and consequently should be made upon a very small scale. Many have succeeded in producing profitable crops of alfalfa only after sowing it for several years in succession. It is suggested that the area seeded at first be small, and that it be divided into a number of subdivisions, each receiving a different treatment; for instance, in the humid sections in regard to the application of fertilizers and lime. The accompanying diagram (Fig. 1) indicates an experiment adapted to the eastern half of the United States. A more simple form of this experiment is shown in figure 2. This calls for the application of lime to the northern half of the area and no lime to the southern half. The eastern half should then receive manure and the western half no manure. This will make 4 plots to the experiment, instead of 9. The strips receiving lime and manure may well be wider than the strips not receiving such treatment. This will reduce the size of the check plot which receives neither application and is thus less apt to succeed. The method, however, is the important feature, and can be modified to suit the prevailing conditions. The idea is to try on the same field at the same time all the different treatments that are likely to

1	2	3	ON PLOTS 1, 2, AND 3, APPLY LIME AT THE RATE OF 4,000 POUNDS PER ACRE.
4	5	6	ON PLOTS 4, 5, AND 6, APPLY LIME AT THE RATE OF 2,000 POUNDS PER ACRE.
7	8	9	ON PLOTS 7, 8, AND 9, APPLY NO LIME.
ON PLOTS 1, 4 AND 7, APPLY NOTHING, EXCEPT LIME ON PLOTS 1 AND 4.	ON PLOTS 2, 5, & 8, APPLY COMMERCIAL FERTILIZER.	ON PLOTS 3, 6, & 9 APPLY BARNYARD MANURE.	

FIG. 1.—A suggested outline for experiments with alfalfa.

LIME AT RATE OF 25 BUSHELS PER ACRE.	LIME AT RATE OF 25 BUSHELS PER ACRE. MANURE (LIBERAL APPLICATION)
NO LIME. NO MANURE.	NO LIME. MANURE (LIBERAL APPLICATION)

FIG. 2.—A suggested outline for simple experiments with alfalfa.

prove successful. The treatment giving the best results can be applied to an increased acreage the succeeding season. In this way the experience which would otherwise require a number of seasons to procure can be obtained at the end of the first year.

Treatment After Seeding.—Alfalfa seeded in the spring needs little care after the first season, more than to mow the weeds a few times during the summer to prevent them from seeding and to keep them from "smothering" the young alfalfa plants. It is well to mow the field two or three times during the season, but the growth of weeds and alfalfa should not be cut too close to the ground until the alfalfa blooms, when it may be mowed close without injuring the plants. It seems to be true that when alfalfa has become well established, frequent close cutting seems to benefit the plant and cause it to grow more vigorously, but this is not true of the young, tender plants. It is true of alfalfa as with any other young plant, that it must form a top growth before or at the same time that it is producing roots. The leaves are the stomach and lungs of the plant, and before the roots can develop the leaves must manufacture the products which are built into the cells and tissue that constitute the roots. If this top growth of leaves is kept cut off before a sufficient root growth has been established to easily restore the top growth, the effect is to check the growth of the plant, weaken it, and perhaps destroy it. Authorities know of good stands of alfalfa that were destroyed by a single close mowing, not due wholly perhaps to the reasons assigned above, but to the fact that the young, tender alfalfa plants which had been strongly shaded by a growth of weeds were suddenly exposed to the heat of the summer sun and a dry period of weather, which, together with the factors named, resulted in killing out the alfalfa almost completely.

A Good Stand.—A good stand of alfalfa is a variable quantity as regards the number of plants required per unit area. In a newly seeded field, where plenty of seed has been sown and the conditions

have been favorable to start the young plants, as many as 120 plants per square foot have been counted. As few as 10 strong young plants per square foot fairly evenly distributed may be considered a fair stand—thick enough to leave. It is questionable whether a very thick stand is as good as a thin or medium stand. Those who advocate sowing a small amount of seed claim that the thinner sown alfalfa starts stronger and will be more productive and remain a good stand longer than that which is sown thicker. One advantage perhaps of the thicker seeding on fertile land is the less coarse growth of stem, which produces a finer quality of hay than the larger, coarser growth resulting from thin seeding.

Alfalfa Dies Out.—Alfalfa plants gradually die out, so that a very thick stand may show a much smaller number of plants per unit area two or three years after seeding. Some notes have been taken on this point at the Kansas Experiment Station. In the spring of 1903 an area of ten feet square was staked out in an alfalfa field seeded in the fall of 1902. On June 18, 1903, 1,133 plants were counted in this plot, or an average of 11.33 plants per square foot. It will be observed that this count was made some six months after seeding. On June 29, 1906, a recounting of this field showed only 670 plants, or 6.8 plants per square foot. On August 9, 1907, the number of plants counted was 403, or 4.03 per square foot. This field was plowed up in the fall of 1907. The decrease in the number of plants between the first and last countings, a period of fifty months, was 730 per 100 square feet, which is a loss of 64.4 per cent.—(Kan. E. S. Bul. 155.)

Pasture.—Alfalfa should never be pastured during the first or second season of its growth. Even an old field of alfalfa should be grazed rather sparingly if a uniform stand is to be maintained. The last crop of alfalfa is frequently pastured off, as other grazing is often short in the autumn. Care should be taken not to pasture too closely in the late autumn, as the plants should be allowed to go into the winter with some growth upon the crowns. This will enable them to withstand the winter better and also to store up reserve food material for a vigorous early growth the following spring. The evil effects of the trampling of the stock while grazing can be overcome by disking to loosen up the compacted ground.

All kinds of live stock may be pastured upon alfalfa. Horses and sheep are more destructive to the stand of alfalfa than are cattle, as they graze more closely. Hogs are apt to injure the stand by rooting unless their noses are ringed. The utilization of alfalfa for hog pasture is in the aggregate probably the most extensive, as nearly every farmer throughout the alfalfa regions makes a practice of this, chiefly because it proves to be a very profitable method of utilizing the crop. An average field of alfalfa will support continuously during the growing season about ten large hogs to the acre and enable them to make good gains, especially if a small quantity of grain is fed in addition. The usual custom is to allow 1 pound of grain a day for every hundred pounds live weight of the hogs.

The principal drawback to the pasturing of cattle and sheep on

alfalfa is their tendency to bloat. This danger can, however, be reduced to a minimum by proper precautions in not allowing the cattle to go on to the pasture with empty stomachs, especially when the alfalfa is wet. When the animals become bloated several remedies are usually at hand for the malady. A large bit an inch in diameter may be tied in the mouth, a piece of rubber tubing may be passed through the mouth to the first stomach, or as a last resort the animal may be tapped to allow the escape of the gas. For this purpose a trochar is best, but in the absence of this instrument a small-bladed knife may be used to make the incision about 6 inches in front of and slightly below the left hip bone. A straw or quill may be used to permit the escape of the gas.

Feeding Value.—Alfalfa is one of the most highly nutritious and palatable of feeds for all classes of farm animals either in the form of green alfalfa or as hay. The following table indicates the actual feeding value of eight different kinds of feed, based on the amount of digestible nutrients contained in them. The values per pound assigned as the basis of calculation are protein, $0.0674; carbohydrates (starches, etc.), $0.0064; ether extract (fats), $0.0112. These figures are merely relative, as the prices of the food elements vary in the different sections and from year to year. It will be noted that the value of alfalfa hay is slightly more than double that of timothy. But it depends on the animal, the way it is fed, time of feeding, etc., whether these nutrients are actually appropriated for animal growth and sustenance.

Actual Feeding Value of Different Feeds Based on Amount of Digestible Nutrients.

Feed	Value per ton	Feed	Value per ton
Fresh alfalfa	$ 7.00	Timothy hay	$ 9.80
Fresh clover	5.96	Cowpea hay	19 76
Alfalfa hay	20.16	Wheat bran	22.80
Clover hay	14.12	Shelled corn	20.16

There is a prejudice on the part of liverymen against alfalfa and in favor of grass hay, owing to the laxative effect of the alfalfa. Many persons hold that the kidneys are unduly stimulated by alfalfa, but this does not appear to be well substantiated by experimental data. On the contrary, there are numerous instances on record where alfalfa hay and green alfalfa have formed a major portion of the ration for the working animals of the farm for years without injurious effect. Alfalfa is a most excellent feed for young growing stock, especially horses, but care must be taken to avoid feeding too much hay to colts, as coarseness is apt to be developed.

For Poultry.—Alfalfa makes an excellent feed for all kinds of poultry. They can be allowed the range of an alfalfa field during the summer or it can be cut green and fed to them. In the winter alfalfa meal fed in a mash may be used as a part of the ration with good effect in maintaining the egg production. It is quite as valuable for this purpose as red clover.

For Bees.—The development of the honey-producing industry in the West has been practically coincident with the extension of alfalfa culture. Statistics indicate that the heaviest yields of honey per stand of bees are secured in the sections showing the greatest acreage of alfalfa. That the honey is of a good quality is evidenced by its standing in exhibitions of this class of products. The number of times that the alfalfa fields come into blossom during the season makes possible the gathering of successive crops of honey.

In Mixtures for Pasture.—Although alfalfa is generally grown alone, there are exceptions to the general practice which indicate that its use in mixtures might profitably be extended in many sections. Alfalfa alone is apt to be a richer feed than is necessary for a steady diet and may well be used in connection with some of the tame grasses. The tendency of a pure stand of alfalfa to produce bloat appears to be overcome if the stock be allowed access to the ordinary tame grasses. An adjoining field of a tame grass answers the purpose, but it is usually best to seed the alfalfa in a mixture with one or more of the staple tame grasses which succeed in the locality in question. A half of a full seeding of alfalfa is recommended. In the East orchard grass and meadow fescue are recommended, as these do not spread by underground rootstocks and endanger the stand of alfalfa. Kentucky bluegrass is apt to run out the alfalfa if this grass is used in the mixture in the bluegrass sections. In the Great Plains region west of Missouri and Iowa smooth brome-grass gives good results when used in a mixture with alfalfa, although this grass spreads by underground rootstocks and has a tendency to crowd out the alfalfa, especially when pastured without being cut for hay.

Winter Grain in Alfalfa Fields.—In the Southwest the mild winters and the occurrence of much of the rainfall during the colder months make it possible to seed wheat or barley in a stand of alfalfa after the last cutting and harvest it at the proper stage for hay the next spring with the first cutting of alfalfa. The presence of a crop of small grain during the winter months prevents the growth of troublesome weeds, which sometimes almost ruin the first cutting of alfalfa. This practice has the further advantage of giving a mixed crop of alfalfa and grain hay, which is regarded as superior to pure alfalfa, owing to the scarcity in that section of feeds rich in carbohydrates or starchy matter. This method is also commendable when for any reason the stand has become thin, as through the action of field mice.

For Dairy Cows.—Dairy cows require high protein feeds in order to produce profitable flows of milk. These can be supplied by feeding nonleguminous roughage and such concentrates as bran and corn meal. Such concentrates are expensive, however, and can be replaced by a feed like alfalfa. Experiments made by the Tennessee Agricultural Experiment Station in regard to the replacing of grain with alfalfa in rations for dairy cows indicated that 1½ pounds of alfalfa will replace 1 pound of wheat bran. The tests showed that with alfalfa hay at $10 a ton and wheat bran at $20 the

saving effected by substituting alfalfa for wheat bran is $2.80 for every 100 pounds of butter and nearly 20 cents for every 100 pounds of milk.

For Beef Cattle.—Alfalfa forms probably the best roughage for fattening cattle, as its lack of bulkiness enables the animals to consume sufficient quantities for rapid gains. It is also very valuable for young growing stock before the fattening period commences.

The Utah Agricultural Experiment Station conducted an experiment extending over a period of five years to determine the quantity of beef produced to the acre from alfalfa hay cut in the different stages of maturity. It was found that hay cut when in full bloom produced 562 pounds of beef annually to the acre, while that cut in early bloom produced 706 pounds. The hay that was not cut until half the blooms had fallen produced only 490 pounds of beef to the acre. At the Nebraska Agricultural Experiment Station 2.41 pounds of beef were produced daily on a full ration of corn and alfalfa, while only 1.48 pounds were produced by a ration of corn and prairie hay.

For Sheep.—Alfalfa is an ideal hay for sheep, but is apt to cause bloat if used as pasturage. It is the custom throughout the mountainous regions of the West to pasture the sheep on the wild grasses in the mountains during the summer and then drive them to the valleys during the winter to be fed on alfalfa hay. As an instance of its value for sheep in the East, the experience of the Wing Brothers, in Ohio, may be cited. Spring lambs cost them $6 per hundred pounds when alfalfa was not used in the ration, as compared with $2.50 per hundred when alfalfa formed the principal part of their feed. It is the practice in the West to cut alfalfa hay for sheep just as it commences to bloom instead of when one-tenth in bloom, as is customary for dairy cattle, or when one-half to two-thirds in blossom if for horses.

For Hogs.—Alfalfa is fed to hogs for the most part in the green state, either as a soiling crop or as pasture. The hay, however, constitutes a maintenance ration for hogs during the winter, and when fed on it sows enter the spring farrowing season in excellent condition. Wherever possible brood sows should secure alfalfa at least during the latter portion of the period of gestation.

At the Kansas Agricultural Experiment Station it has been shown that an acre of alfalfa produced 776 pounds of pork during the season. This calculation was made by deducting the probable gain due to the small ration of grain fed in connection with the pasturage. In another experiment it was shown that for every bushel of Kafir corn meal and 7.83 pounds of alfalfa hay the hogs made a gain of 10.88 pounds. When the alfalfa was withheld from the ration the gain was only 7.48 pounds for each bushel of grain fed.

For Horses.—Alfalfa may be fed to horses both in the green state and as hay. Numerous instances have been recorded where horses have performed heavy work during the summer season on nothing but green alfalfa.

Effect on the Land.—Alfalfa acts in a manner similar to red

clover and other leguminous crops in increasing the yields of the succeeding crops. The roots add nitrogen directly to the soil and are efficient by reason of their deep-feeding habit, bringing up other mineral constituents from the lower layers of the soil and thus rendering them accessible to the shallow-feeding crops.

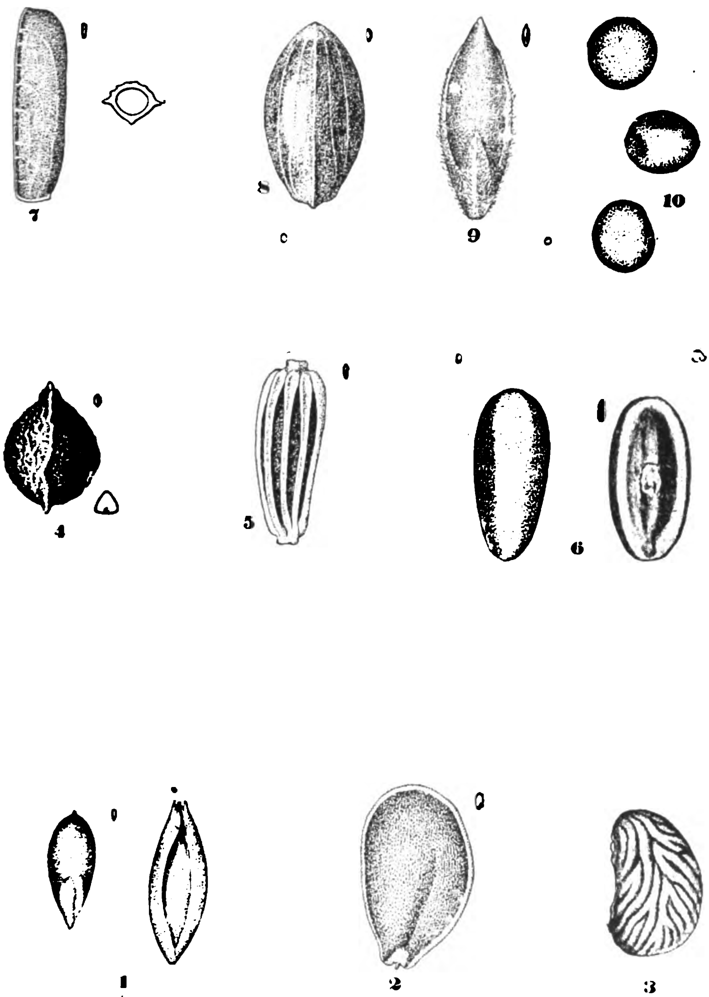
Results at the Wyoming Agricultural Experiment Station show that on irrigated land the effect of alfalfa was to increase the value per acre of subsequent crops as follows: Potatoes, $16; oats, $16; wheat, $8 to $12. These increased gains were made without cost in fertilizing the land, as the alfalfa had been regularly cut for hay for five years. In Colorado and Nebraska the yields of grain are sometimes nearly doubled when immediately preceded by alfalfa.

As an instance of the effect of alfalfa on soils in the South, it may be mentioned that on a plantation near Shreveport, La., 23 bales of cotton, weighing 575 pounds each, were produced on 18 acres the season after an 11-year-old field of alfalfa had been plowed up. This soil had been in cotton for several years previous to the seeding of the alfalfa and had not given more than one-half bale of cotton to the acre in any one season.

Adaptability to Rotations.—The value of a successful alfalfa field is so great that there is always the temptation to let it stand as long as it will produce paying crops. The difficulty of getting rid of a stand of alfalfa as well as the uncertainty of establishing the new stand and the high price of the seed all work against the utilization of alfalfa in the ordinary rotations of the farm. There are many fields in the West more than 25 years old which are still giving satisfactory crops of hay. With the gradual exhaustion of soil fertility, alfalfa is securing a place in the farm rotations in spite of the drawbacks to its use in this manner.

Getting Rid of Alfalfa.—The methods adopted in eastern Colorado, where alfalfa is used to a great extent in short rotations, is to plow shallow in the fall and then plow deep the following spring. The plows are sometimes provided with a knife attachment to the land side to cut the roots near the outer edge of the next furrow. A riding plow is preferable owing to its rigidity. The fall plowing exposes the crowns and a small portion of the root to the weather. The deep plowing the following spring so effectualy buries the crowns that the limited amount of reserve food present in the severed portions does not enable them to reach the surface. The deep plowing also prevents the cultivator teeth from catching on the alfalfa roots when cultivating the succeeding crop. In some irrigated sections it is the practice to flood the field to kill the plants before plowing. In still other sections the stand is very heavily pastured, preferably with hogs. This so reduces the vitality of the plants that it is comparatively easy to get rid of them.

Alfalfa Varieties.—Under most conditions, especially in the alfalfa districts, ordinary alfalfa, whether from American or European grown seed, gives quite as satisfactory results as any of the special varieties. In certain sections of the country, however, special varieties of alfalfa have been found to be more valuable than



TIMOTHY SEED AND ITS IMPURITIES.

1, Timothy (*Phleum pratense*) without and with the glumes; 2, Pepper Grass (*Lepidium virginicum*); 3, *Potentilla monspeliensis*; 4, Sorrel (*Rumex acetosella*); 5, Oxeye Daisy (*Chrysanthemum leucanthemum*); 6, Rib-grass Plantain (*Plantago lanceolata*); 7, Vervain (*Verbena hastata*); 8, Witch Grass (*Panicum capillare*); 9, Crab Grass (*Syntherisma sanguinale*); 10, Dodder (*Cuscuta trifolii*)—the small figures natural size.

the ordinary forms. Of these the Turkestan, Arabian, and Peruvian, varieties have been introduced through the Office of Foreign Seed and Plant Introduction of the United States Department of Agriculture.

Turkestan.—Turkestan alfalfa was introduced into the United States in 1898, and has since been tried in all parts of the country. It has been found to be superior to the ordinary alfalfa in only limited sections. It is decidedly inferior in the humid sections east of the Mississippi River, but has given somewhat better results than the ordinary alfalfa in the semiarid portions of the Great Plains and in the Columbia Basin.

Hardy.—There have appeared during the past years several strains of alfalfa which are characterized by their hardiness and general ability to withstand conditions which are rather too severe for the best production of ordinary alfalfa. There is some variation in the characteristics of these alfalfas, which may be grouped under this general head, but they agree in showing a considerable diversity in the color of the flowers, which varies from yellow to blue, green, and various shades of violet and purple. These colors are often clouded with a smoky hue. The predominating color is the violet of the ordinary alfalfa. The most conspicuous examples of hardy alfalfa are the commercial sand lucern and the Grim alfalfa of Minnesota.

The sand lucern has been grown for a number of years in this country. It has recently been found to be adapted to the colder and drier sections of the country, where it is proving the equal of any of the alfalfas under test. It seems particularly adapted to withstand the cold winters of the Northern States, where ordinary alfalfa is very likely to winterkill.

Dry-Land.—Dry-land alfalfa is the name usually given to ordinary alfalfa seed produced for one or more generations in the semiarid sections without irrigation. It is proving somewhat superior to ordinary alfalfa under semiarid conditions, and as a drought-resistant alfalfa is about equal to Turkestan alfalfa and sand lucern.

Arabian.—Arabian alfalfa is proving of special value in the southwestern portion of the United States, where the winters are very mild. It is characterized by its large leaflets and the hairiness of the stems and leaves, quick recovery after cutting and very rapid growth during the growing season, and also by its ability to grow at cooler temperatures than ordinary alfalfa. On the other hand, it is extremely tender to actually freezing temperatures and generally winterkills in all except the Southern and Southwestern States. Its quick recovery after cutting and its longer growing season enable several more cuttings per season to be obtained than are possible for the ordinary alfalfa. Unfortunately seed of this variety is not yet on the market.

Peruvian.—Peruvian alfalfa is similar to Arabian alfalfa, and is likewise characterized by its long growing season and lack of hardiness. It grows taller than Arabian alfalfa, but the stems are

more woody. The seed is not yet on the market in this country, as it is not grown in Peru or elsewhere in large commercial quantities.

Seed Production.—The alfalfa seed producing sections of the United States are much more limited in extent than are the sections where the hay can be successfully raised. Alfalfa sets seed in paying quantities only when there is a comparative shortage in the moisture supply. In the irrigated sections it is the practice to withhold one irrigation when seed is desired. In the sections where alfalfa is raised without irrigation, a seed crop is usually secured in the dry years only.

Alfalfa requires a dry, hot season for the best development of the seed crop, and for this reason it is customary to save that crop for seed which will mature during the hottest and driest part of the summer. This is ordinarily the second crop, but south of central Kansas it may be the third crop, and in the northern sections may have to be the first crop, owing to the short growing season. In sections where the second crop would come only a little too late for the heat of midsummer, it is the practice to clip back the first crop when half grown. The alfalfa then comes on more evenly than had it not been cut back, and in addition blooms considerably earlier than had the full first crop been matured.

When allowed to make seed the alfalfa should be cut when from two-thirds to three-fourths of the pods have turned brown, as this will insure the greatest quantity of good seed. The methods of harvesting the seed vary widely in the different sections. A self-rake reaper, a mower with a dropping or bunching attachment, or a self-binder with the tying attachment removed is sometimes used. These leave the alfalfa in convenient forkfuls which reduce the amount of shattering in handling.

Alfalfa is thrashed from the field if possible, but it is often necessary to stack the crop before thrashing. An alfalfa huller built along the lines of a clover huller is usually most satisfactory, but few sections produce enough alfalfa seed to justify the use of these special hullers. Very satisfactory results can be secured with the ordinary grain thrasher by screwing down the concaves and providing a set of alfalfa sieves.

A thin stand of alfalfa is best for seed-producing purposes. The yields usually run from 2 to 5 bushels to the acre, but occasionally much higher yields are secured. Most of the alfalfa seed is produced in Utah, Idaho, Colorado, California, Arizona, Montana, Kansas, and Nebraska. The supply of seed raised in this country is far short of the demand, as is evidenced by the fact that over 6,000,000 pounds were imported during 1906 .

Alfalfa in Cultivated Rows.—Preliminary experiments indicate that the growing of alfalfa in cultivated rows for seed offers considerable promise of success in regions where the rainfall is sufficient for only one or two cuttings of alfalfa hay. Probably the most extensive area to which this method promises to be adapted is the Great Plains area immediately west of the one-hundredth meridian in Texas, Oklahoma, Kansas, Colorado, Nebraska, and South

Dakota. This section is characterized each season by periods of relative drought, which are in accordance with the needs of alfalfa for seed production.

Weeds.—Over a considerable portion of the country weeds constitute the worst enemy of alfalfa. This is especially true in the humid sections and in those parts of the West and Southwest where the bulk of the rainfall comes during the comparatively mild winters.

In the irrigated sections of the West, especially in those sections characterized by rainfall during the comparatively mild winters, the growth of the wild barleys (*Hordeum* spp.) is a decided drawback to the successful production of alfalfa.

Since alfalfa is not usualy a clean-cultivated crop the problem of weed destruction is a serious one. Disking is usually the most effective remedy for weeds, as the alfalfa is generally benefited by the operation, while the weeds are greatly injured owing to their different root systems. In sections where the wild barleys are troublesome it is sometimes thought necessary to burn the first crop of hay. Another method is to cut the first crop while the wild barley is still immature and feed the mixture of alfalfa and grass hay. The objection to this method is that it necessitates the cutting of the alfalfa when too young. A heavy growth of crab-grass is sometimes burned in the early spring.

Dodder is one of the very worst weeds. It germinates in the ground and the young plants soon attach themselves to the alfalfa seedlings. As soon as the threadlike stem is firmly attached to the alfalfa plant the stem connecting it with the ground withers away. Thenceforth the dodder lives entirely on the alfalfa. It is very difficult to eradicate when once established, and for this reason great care should be taken to avoid introducing it with the alfalfa seed at seeding time. Grazing close with sheep has been recommended as being effective in holding dodder in check. If dodder appears in isolated spots through the field, it is advisable to cut the affected alfalfa plants very low and remove them. Destroying the dodder by burning with different inflammable materials has occasionally proved successful, but it is apt to be more expensive than the removal of the affected portions of the plants. If the stand of alfalfa is badly affected with dodder, the alfalfa should be plowed up before the dodder goes to seed and the land kept in cultivated crops for two or more years.

Rodent Pests.—The worst animal pests are gophers, ground squirrels, prairie dogs, and mice. These are especially troublesome in the western half of the country, where they injure the alfalfa by eating the roots as well as the foliage. The mounds of gophers are very annoying, as they interfere with mowing. These pests are less troublesome where irrigating water is available with which to drown them out. The burrows, however, cause the waste of much water when irrigating. Poisoning and destruction by traps and cats are the best means of holding the pests in check.

Insect Pests.—Grasshoppers are at present the worst insect ene-

mies with which alfalfa must contend. These are most troublesome in the arid sections of the West, where the alfalfa fields may be the only succulent growth for miles, and the grasshoppers from large areas congregate upon the relatively small fields of alfalfa. Blister beetles also prove troublesome at times when they appear in considerable numbers. The general practice is to cut the alfalfa on the appearance of any such pests, when they will be forced to starve or migrate. The alfalfa and clover chalcis fly (*Brucophagus funebris*), found also in Europe and Siberia, is proving destructive to the alfalfa seed crop wherever it is grown.

Plant Diseases Affecting Alfalfa.—There are two general classes of diseases which affect the alfalfa plant, namely, those which affect the roots and those which attack the stems and leaves. Of the former, root-rot (*Ozonium omnivorum*) is the most important. This disease is practically identical with cotton root-rot and prevents the successful production of alfalfa in considerable portions of eastern and southern Texas. It spreads in widening circles throughout the field, causing an almost complete destruction of the stand as the disease progresses.

SPECIAL INSTRUCTIONS FOR GROWING ALFALFA.

New York and New England States.—Alfalfa is grown with some difficulty on the soils in New York and the New England States, with the exception of the limestone areas. Outside of the limestone regions liming is always necessary. Even in the limestone areas it is often advisable to apply lime. At least a ton of lime to an acre is usually required, and more than this may be necessary on the heavier soils. Well-rotted barnyard manure is the most satisfactory fertilizer, but a complete commercial fertilizer may be used in the absence of manure.

Inoculation with nitrogen-fixing bacteria is essential unless the soil is known to be naturally supplied with these germs. The seed should be sown alone at the rate of 20 to 30 pounds per acre. It may be drilled or sown broadcast and covered lightly with a smoothing harrow. Sowing with a nurse crop in the early spring is practiced in some sections, but better results are usually obtained by waiting until early summer and seeding the alfalfa alone.

Good results may also be obtained by seeding the latter part of July on land which has been repeatedly harrowed for several weeks. This method is recommended in case weeds are thought to be troublesome. Alfalfa is more likely to winterkill under this last method, but this danger may be less than that of the weeds on a weedy soil if sown in the spring.

Middle Atlantic and Southern States.—In the Middle Atlantic and Southern States the limestone soils are best adapted for the production of alfalfa. Even these soils often require liming for the best success. In the nonlimestone regions the soils require heavier liming to overcome the natural acidity of the soil. A deep, fertile, well-drained, well-limed soil is required. Well-rotted barnyard manure is the most satisfactory fertilizer. Green-manure crops are also efficient in building up the humus content of the soil. If nei-

ther of these can be used, commercial fertilizers can be applied. A good formula is muriate of potash, 75 pounds; acid rock, 250 pounds; and nitrate of soda, 50 pounds, to the acre. Inoculation with nitrogen-fixing bacteria is almost always essential to success. The seed should be sown without a nurse crop, and at the rate of from 20 to 30 pounds to the acre .

Spring seeding is generally unsatisfactory, as the plants are very likely to be choked out by the weeds of midsummer. Late fall seeding is open to the same objection and to the additional drawback of being likely to cause winterkilling. The ideal time of seeding is in the late summer after the greatest danger of weeds is past. Repeated harrowings for six weeks preceding the sowing time will destroy the successive crops of germinating weeds and put the land into an ideal, well-settled, finely pulverized condition for the alfalfa seed. The date of the seeding will vary as one passes from north to south. In the latitude of Washington, D. C., August 15 is usually best; in North Carolina, September 15 is recommended; and in the extreme South the seeding may be delayed until the middle of October. In the south the danger of fall drought sometimes makes it necessary to postpone the seeding until February.

Ohio, Michigan, Indiana, Illinois, Iowa, Missouri, Eastern Kansas, and Eastern Nebraska.—Throughout this section late summer seeding is giving the best results, although spring and fall seeding are usually successful in the western part of this section. Liming and inoculation are advisable, except in Kansas and Nebraska. The seed should be sown alone at the rate of about 20 pounds per acre. If sown in the spring the soil can not usually be put into proper condition before the middle of May.

Montana, North Dakota, South Dakota, Minnesota, and Wisconsin.—In the North Central States it is necessary to seed alfalfa in the spring or early summer, owing to the inability of the fall-seeded plants to make sufficient growth to prevent their being winter-killed. A month or six weeks should usually be allowed for freshly plowed land to settle. If spring seeding is practiced, fall plowing is usually necessary. Corn-stubble land may, however, be disked in the spring and settled firmly enough by two or three harrowings. In the less arid eastern portion of this section early summer seeding often gives the most satisfactory results. In the semiarid portions of this section care must be taken to conserve the soil moisture by proper methods of culture previous to seeding.

Inoculation with nitrogen-fixing bacteria is usually necessary and should be used unless the soil is known to be well supplied with the germs. The seed should be sown at the rate of about 20 pounds to the acre, generally without a nurse crop, although in Wisconsin a nurse crop with spring-seeded alfalfa has frequently been successfully used. In all cases the alfalfa should be allowed to go into the winter with at least a month's growth, as this will hold the snow and tend to protect the crops from injury during the winter.

Irrigated Sections.—Alfalfa is especially adapted to the irrigated sections of the United States. The dry climate is apparently

essential to the best growth of the plants and the water supply can usually be controlled so as to be applied when most needed. The seeding usually takes place in the spring, and quite often some small-grain crop is seeded with the alfalfa. The alfalfa is so thoroughly at home that it succeeds in spite of the nurse crop rather than by reason of it.

In the extreme South and Southwest it is often the practice to seed alfalfa in the fall with small grain. In most cases the land receives a thorough irrigation shortly before seeding. The crust is broken when the seeding takes place and the moisture is usually sufficient to enable the plants to make a satisfactory start. It is sometimes the practice to irrigate the ground immediately after seeding and then irrigate a second time just as the seedlings are trying to break through the crust. The plants are then able to get through the crust before it has a chance to form a second time. This method, however, is not usually to be recommended.

It is generally the best practice to irrigate alfalfa a few days before cutting and then give a second irrigation when the crop is about half grown, which is commonly about fifteen days after cutting. The advantage of irrigating before rather than immediately after cutting, as is often the practice, is that there is not the delay in starting the new growth. This delay may be injurious, as several days are usually required to get the hay off the ground, and in the meantime there is almost no growth on the part of the alfalfa.

Semiarid Regions.—The principal factor in the successful production of alfalfa in the semiarid sections is the conservation of soil moisture before the alfalfa is seeded. The proper preparation of the ground for planting usually calls for special treatment of the soil for at least a year preceding the time of sowing in order that the rainfall of the entire year may be stored up in the ground and may be available for the young alfalfa plants.

Fall seeding is not usually advisable, owing to the danger of drought and the small growth which the plants are able to make before winter. For this reason spring seeding is usually practiced, even though the danger of weeds in summer is considerable.

The seed should be sown broadcast or drilled in at the rate of 8 to 12 pounds of good seed per acre. A more nearly even stand can be secured by dividing the seed and sowing one-half each way across the field. If sown broadcast, a harrow should be used to cover the seed 1½ to 2 inches deep. If the soil is sandy and likely to blow before the plants can make sufficient growth to cover the ground, a half bushel of oats per acre may be seeded with the alfalfa.

Eastern Oregon and Eastern Washington.—Alfalfa is thoroughly established in the irrigated portions of this section and its culture is gradually being extended in the semiarid nonirrigated sections, although much lighter yields are obtained than where the crop is grown under irrigation. In the absence of more drought-resistant plants, however, alfalfa takes front rank as a leguminous forage plant. On dry soils it is slow in becoming established, and not until the third year are the best results to be looked for.

The ground should, if possible, be summer fallowed the previous season to destroy the weeds and conserve the moisture for the germination of the seed. Intertilled crops, such as corn and potatoes, instead of the summer fallow, may precede alfalfa. Spring seeding is generally practiced, as the fall rains usually come too late to permit fall seeding.

Some Alfalfa Don'ts.—Don't fail to provide for ample inoculation; soil from an old alfalfa field is best. Don't sow poor or weedy seed. Don't sow on a weedy soil. Don't sow on any but a sweet, well-lined soil. Don't sow on poorly drained soil. Don't sow on any but a finely prepared, well-settled seed bed. Don't pasture the first or second year. Don't lose the leaves; they constitute the best part of the hay. Don't seed a large acreage to begin with. Experiment on a small area first. Don't give up. Many prominent alfalfa growers finally succeeded only after many failures.

(*Authorities Consulted on Alfalfa.*—U. S. Dept. Agr. F. B. 185; Cornell, B. 232; Texas A. E. S., B. 109; B. P. I., B. 519; Kan., B. 155; same, B. 109; Ark. B. 75; Wyo. B. 43; Ind. Cir. 27; Kansas B.'s 85, 90, 104, 114, 133, 134, 151; Ont. Dept. Agr. B. 165; Mich. B. 199; Ill. B. 76; Utah B. 61; Mont. Cir. 5; S. D. B. 94; Ohio B's. 80, 113 and 181; Utah B. 58; Tex. B. 66; Colo. B's. 13, 110, 111 and 128; Ala. B. 127; Cornell B. 221; Mo. Cir. 40; Wis. B. 112; Mich. B. 225; same Cir. 1; Cornell B. 237; Okl. B. 71; Utah B. 48; Tenn. B. 21; Kan. B's. 155 and 175; Ind. B. 122; Va. B. 154; Wash. B. 80; Mo. B. 72; N. J. B. 148.)

RED CLOVER.

Red clover is utilized both as a hay and as a pasture crop and often as a soiling crop. It is sometimes used as a green-manure crop to be plowed under if the ground is poor in humus. Even where it is cut for hay and only the roots and stubble turned under it has a marked influence in increasing the yields of succeeding crops. It makes an ideal hay for cattle and in the clover sections should constitute from one-half to two-thirds of the roughage ration of milch cows. Sheep and young stock of all kinds make excellent gains on either the pasture or the hay. In addition to its usefulness as a food for animals it has a most important effect upon the land in maintaining the supply of nitrogen in the soil. By means of the nitrogen-fixing organism on its roots the red clover plant is able to gather large quantities of nitrogen from the air and leave it in the soil in a form which can readily be utilized by growing crops. It not infrequently happens that the yield of a grain crop can be doubled by the growing and plowing under of a crop of clover.

The most serious problem at present confronting the American farmer in many of the clover sections is the increasing difficulty of successfully maintaining stands of clover upon the farm. With continuous cropping and the consequent depletion of the soil of humus and plant food the difficulty of growing red clover is greatly increased. This condition must be met and solved, since the loss

of clover or its equivalent from the rotation leads rapidly to a run-down farm and unprofitable crop yields.

It should be emphasized, however, that the mere introduction of red clover into the farm rotation is not in itself a sufficient procedure to maintain indefinitely the productivity of the farm. The clover plant adds only the nitrates to the soil and removes large quantities of potash, phosphorus, and lime from the soil, especially when cut for hay and the manure resulting therefrom is not returned to the land.

Description of the Red Clover Plant.—The accompanying illustrations indicate the general appearance of the red clover plant. The plant is entirely herbaceous and is composed of numerous leafy stems arising from a crown. It usually lives only two years and for this reason is especially adapted to short rotations. The flowers are borne in compact clusters or heads at the tips of the branches. There may be a hundred or more flowers to a single head. The flowers are rose-pink, somewhat similar in shape to pea flowers but much more elongated and smaller, being one-half inch in length and one-sixteenth inch in width. The pods bear little resemblance to the pods of most other legume-bearing plants; they are small, short, and break open transversely instead of longitudinally as do pea and bean pods. The kidney-shaped seeds are one-twelfth of an inch long and vary in color from yellow to purple. The stems comprise about three-fifths of the total weight of the plant above ground and are usually somewhat hairy. Each leaf is divided into three oblong leaflets, usually with a pale spot in the center of each. The roots are much branched but usually deep feeding and are ordinarily well supplied with the nitrogen-gathering tubercles.

Adaptability to Various Soils and Climates.—Red clover is the staple leguminous forage crop in the North Central and Northeastern States. Although it is grown principally in the States bordering the Great Lakes, a great deal is also raised in North Dakota, South Dakota, Montana, Oregon, Washington, and the Southwestern States. It does not give its best returns in the extreme South nor is it always quite able to withstand the more severe winters in North Dakota and Minnesota.

In irrigated sections clover can be grown, but usually it can not compete with alfalfa, which makes more cuttings in a season and lasts much longer from one seeding than the red clover plant. In some irrigated sections red clover is preferred, as in high mountain valleys where the growing season is too short for three crops of alfalfa and especially where a leguminous hay crop is desirable in connection with the customary grain crop. It makes its best growth on rich, fertile, well-drained soil containing an abundant quantity of lime and reasonably free from weeds; but it is not so exacting as alfalfa in these respects. To low, poorly drained soils it is not so well adapted as alsike clover. Alsike will also succeed on the so-called clover-sick lands upon which for one reason or another red clover can no longer be successfully grown.

Choice of Seed.—It is important that considerable care be taken

in choosing the seed to be sown. If poor seed be used the expected crop may be a partial or total failure. In addition the loss of the labor involved in putting in the crop may be a considerable item of expense. It is essential to know the characteristics of both good and poor seed in order that an intelligent selection may be made.

Characteristics of Good Seed.—Good red clover seed is plump or well filled, bright with a slight luster, the color of individual seeds ranging from violet to light yellow. The individual seeds should be at least of medium size and fairly uniform. The seed should be free from adulterants of any kind and also free from seeds of noxious weeds. Very new seed is often undesirable to sow because of the hard seed it contains.

Hard Seed.—The so-called hard seed has a coat in such a condition that it absorbs moisture very slowly and may not germinate for a period of several weeks or even months. In very new seed the proportion of hard seed may amount to as much as 50 or 60 per cent. A year or two later a much greater proportion of the same seed will germinate promptly. A germination test readily shows the proportion of hard seed present in any given sample.

Advantages of Home-grown Seed.—Several advantages attend the use of home-grown seed. In the first place it is quite certain to produce a crop especially adapted to the local climatic conditions, more so than seed brought in from a distance and usually from an unknown source. Home-grown seed is not likely to contain impurities foreign to the neighborhood and it is usually possible to obtain seed from fields known to be free from dodder, buckhorn, dock, etc. The age of home-grown seed may usually be definitely determined. This is often impossible with seed purchased in the open market. Open-market seed may be excellent or it may be very undesirable. If seed is to be purchased from other localities care should be taken that it comes from a region possessing at least as rigorous a climate, especially if there is any necessity of seeding a hardy strain of clover.

Characteristics of Poor Seed.—Red clover used may be poor and undesirable from several points of view. Such seed is constantly being sold to farmers and should be recognized and rejected. It may be poorly developed, many seeds being shriveled and dull brown in color. Such seeds will not produce plants. Often red clover is adulterated by the use of yellow trefoil, dead clover seed, cheap imported seed, or weedy screenings. Each of these constituents reduces the stand of healthy plants.

Cleaning Red Clover Seed.—Some of the weed seeds appearing in red clover seed can be removed by the farmer by the use of a wire-cloth sieve containing 20 meshes to the linear inch. Most of the clover seeds of medium size are held back by such a sieve and practically all the smaller weed seeds pass through. The true clover dodder which is a very noxious pest in clover fields is quite effectively removed in this way. Most of the seeds of the field dodder are also removed. Seed of buckhorn, wild carrot, wild chicory, thistles, and others of similar size are mostly held back by the sieve. The small-grained clover seed imported from Europe largely passes through

such a sieve. A method of separating buckhorn seed from clover has been devised and published by the United States Department of Agriculture. In brief this method consists of mixing with the seed containing the buckhorn thoroughly wetted sawdust. The buckhorn seed becomes sticky on being wet and readily attaches itself to the sawdust. The entire mass is then immediately screened, when the larger particles of sawdust with the buckhorn attached are readily separated from the clover seed. This work should be done immediately before sowing the clover seed which with the small particles of sawdust that pass the screen need to be dried only sufficiently to enable the seeding to take place readily. This is an effective means of removing practically all viable buckhorn seeds and is easily accomplished by the farmer who handles a comparatively small quantity of seed which is not necessarily bulked immediately after the somewhat damp seed has been screened out.

The Purchase of Red Clover Seed.—The quality of the seed as previously discussed should receive more attention than has usually been given it. If home-grown seed produced under known conditions is not available, samples should be procured from reliable dealers. These should be examined for adulterants, weed seeds, and shriveled seeds. They should also be tested for germination before purchasing. Cheap, poor seed is often mixed with good seed and sold at the price of good seed.

Making the Seed Test.—In the absence of more accurate methods an estimate should be made of the proportion of true red clover seed and of weed seeds and other impurities. From the red clover seed separated from all impurities a counted number, as 100, should be taken just as they come. These seeds should be placed between layers of moistened cloth or paper or merely covered in a bed of sand or light soil. The germinating receptacle should be held at a temperature of a living room, varying between 65° and 85° F. Between the third and sixth days the sprouting ability of the seeds should be shown. Seeds which at the close of a week are still hard, not yielding to the pressure of a knife blade, are "hard" seeds and are to be considered little better than dead seeds for sowing. It should be borne in mind that the sowing value of the seed is represented by the amount of true clover which will germinate with reasonable promptness. Thus, if four-fifths of a sample is pure clover and but three-fourths of this clover will sprout, then only three-fifths, or 60 per cent, of the original seed as offered will grow. The examination of the seed is facilitated by the use of a magnifier.

Soils Adapted to Red Clover.—As a general rule throughout the clover belt any soil that will grow corn successfully will produce satisfactory crops of red clover. A deep soil is desirable for red clover in order that it may utilize fully its extensive root system, which may extend down as far as 5 or 6 feet. Red clover is a legume that will grow in soil relatively low in nitrogen so long as there is a sufficient supply of this element to start the plants, until they have opportunity to develop tubercles on the roots. Absence of sufficient humus, however, makes it very difficult if not impossible to secure a

profitable stand of clover. Red clover will not succeed if the ground is poorly drained or if the land is in any way boggy. On such soils it is better to seed alsike instead of red clover.

Preparation of the Seed Bed.—Clover is usually seeded in the spring on winter grain. In such cases no special preparation of the seed bed is necessary, as the frost has usually cracked the ground sufficiently to render natural covering a reasonable certainty. If seeded with a spring-sown nurse crop the preparation accorded the land for the grain crop is usually sufficiently thorough for successful results with red clover; but it is necessary to have the seed bed fine and reasonably firm if prompt germination and proper establishment of the young plants is to be accomplished.

When clover is seeded alone—a very desirable practice on poor, run-down farms—a firm, fine, well-settled seed bed is highly desirable. For this reason the clover should not be seeded on freshly plowed land which has been given no opportunity to settle. Several workings with soil packers or harrows are usually necessary unless a heavy rain intervenes to settle the ground to the proper condition. If the ground has been previously planted to an intertilled crop, such as corn, plowing is not always necessary, as a good disking will generally put the ground in proper condition for red clover.

Fertilizers for Red Clover.—Under ordinary conditions the red clover crop is able to succeed by utilizing whatever fertilizer has been used in connection with the crops immediately preceding or with which the clover is sown; but on soils which are somewhat low in fertility profitable returns are made more certain by top-dressing with manure previous to the time of seeding. The soil may lack a sufficient quantity of one or more of the principal fertilizer elements essential to the production of red clover. This deficiency may be supplied in the form of commercial fertilizer if manure is not available in sufficient quantities. Clover soils in the clover belt generally appear to be somewhat deficient in phosphorus but usually have enough potash and nitrogen.

Seeding Red Clover.—Red clover often fails to catch because it is not planted sufficiently deep to insure proper moisture conditions for the young seedlings. In light or sandy soils the seed should be covered 1½ to 2 inches deep, while in clay soils the covering should be about 1 inch. For prompt germination it is advisable on reasonably loose lands, especially sandy lands, to roll the ground after seeding. If a smooth roller is used, it should be followed by a light harrow to roughen the surface and thus prevent rapid evaporation of the soil moisture. Shallow seeding is especially disastrous in case of insufficient rainfall. Red clover may be seeded about six weeks before frost in the autumn or in the early spring while the ground is still freezing and thawing daily. It may also be seeded in the late spring after the ground has become warm. The late summer or early fall seeding is recommended in seasons where there is ample moisture or where spring seedings for any particular reason do not succeed. In seeding clover, 8 to 10 pounds are usually suf-

ficient. This weight of seed is often mixed with 10 to 12 pounds of timothy.

Where no difficulty is experienced in growing red clover, it is the customary practice to seed with some nurse crop. In sections growing winter wheat it is usually seeded on the wheat in early spring, when the alternate freezing and thawing of the honeycombed ground covers the seeds sufficiently to render a good stand reasonably certain. In sections where the seeding of spring-sown grain is the rule it is the general practice to seed the clover either with or immediately after the grain. In light sandy soils the two may be drilled into the grain furrows, as under such conditions the deep covering of red clover is an advantage. On other soils it is necessary to cover the clover to a less depth than the grain, and this may be brought about by seeding the clover in front of the drill shoes or by seeding it after the drill and harrowing it in. When seeded in the spring on fall-sown grain, wheat is the usual nurse crop, but rye is more favorable to the growth of clover, because it produces less shade than wheat. If the rye is used in spring for pasturing, the trampling incident to the pasturing will assist in covering the clover seed.

Seeding Without a Nurse Crop.—Where none of the methods already discussed prove successful it is necessary to seed the clover alone and give the crop the entire use of the ground. By seeding clover in the spring without a nurse crop, a good crop of hay may be obtained the first season, the stand is more certain, and the plants are not injured by the lodging or shading of the grain. If weeds prove troublesome, they may be clipped back with the mower. Should there be any tendency to drought during the summer, the water supply available for the clover plants is much greater when seeded alone than when seeded with a nurse crop.

Inoculation of Red Clover.—In order to make its best growth, the red clover plant must be supplied with nitrogen-gathering bacteria on its roots. The tubercles containing these bacteria are shown herein. Fortunately, this crop has been grown so long in this country that most soils appear to be fairly well supplied with these germs, and usually no artificial application of them is necessary. When the clover is being tried as a new crop in a section it often does not become well inoculated until it has been grown for two or three seasons on the same piece of land, after which natural inoculation takes place and good crops are grown without further difficulty. By scattering the clover straw and chaff (remaining after hulling the seed) on the land to be seeded to clover, it has been observed that beneficial results will follow, more in fact than would naturally be expected merely from the manurial effect of the clover stems so applied. It is probable that a portion of the observed increase in the vigor of the clover plants is due to the bacteria which may be applied with the leaves and chaff. When seeding clover upon land for the first time, it is well to provide for artificial inoculation, but after clover is established on a farm this procedure is usually unnecessary. This artificial inoculation may be accomplished either by scattering

soil from some old, healthy, weed-free clover field or by the use of pure cultures.

The Soil-Transfer Method of Inoculation.—Inoculation by the soil-transfer method is generally more certain in its results than the pure-culture method, but where the soil is brought in from some outside locality not known to be free from noxious weeds, insect enemies, and plant diseases, there is danger of introducing such pests.

The soil-transfer method consists in scattering over the new ground, at the rate of 200 to 300 pounds to the acre, soil from a healthy clover field where the plants show an abundance of the tubercles on their roots. It is suggested that the seed be mixed with a small portion of this soil and the remainder drilled or scattered broadcast and immediately harrowed in. This should be done preferably on a cloudy day or toward evening, as the sun's rays are very injurious to the germs; but if the person who scatters the soil walks directly in front of the harrow the sun has practically no opportunity to harm the germs. To facilitate even scattering, the soil may be mixed with two or three times its own weight with ordinary soil obtained close at hand to save carriage charges.

The Pure-Culture Method of Inoculation.—The results with pure cultures are less certain than where the soil-transfer method is employed, but the pure-culture method has the advantages of greater ease of transportation and freedom from danger of introducing harmful pests upon the farm. The method of inoculation by pure cultures may be carried out in either of two ways: (1) A bottle of pure culture of the proper kind of bacteria is opened and the culture mixed with a convenient quantity of water; this diluted culture is now thoroughly mixed with a considerable quantity of soil, preferably from the field where the legume is to be sown; the treated soil is then distributed in the same manner as when inoculation is made by the use of soil from an old field. (2) A pure culture of the proper kind of bacteria is prepared according to the directions accompanying the bottle, and is then applied to the seed is such a way that all of the seed may be moistened, though not soaked. The seed should be planted as soon as practicable after this treatment—that is, as soon as it is sufficiently dry for convenient handling. Drying may be facilitated by adding dry, sifted earth, preferably from the field in which the leguminous crop is to be grown. The nodule bacteria very often die within a week after the seed is inoculated and dried; it is therefore highly desirable that the inoculation be made the same day the seed is sown. Inoculated seed should never be dried in the sun, as direct sunlight is quickly fatal to the bacteria.

Treatment the First Season.—When seeded with a grain nurse crop no special treatment is given the clover the first season. It develops in the stubble after the grain has been cut and occasionally may afford some pasture the same fall. If the late summer be especially favorable sufficient growth may be made for a cutting of hay, and in some cases a crop of seed has been secured. The stand, however, is apt to be injured by the cutting, and it is usually best to clip back the growth to check the development of the plants. When

seeded in the fall in corn or with rape one or two crops may be expected the next season in addition to considerable pasture. A top-dressing of barnyard manure acts very favorably on red clover at any time.

Treatment the Second Season.—Common red clover usually lives but two years. The second season the first crop is usually cut for hay and the second crop for seed. The aftermath or rowen is then pastured or plowed under. In sections where the season is not long enough to permit the clover to set seed after a full hay crop has been harvested it is necessary if seed is desired either to pasture back the first crop of clover or to cut it early when just coming into bloom, rather than to wait until it is in full bloom, as is usually recommended. When mixed with timothy the stand is often allowed to remain three or four years with the clover gradually decreasing. If it is desired to retain a stand of clover for more than two years seed must be allowed to mature during the late summer the second season. This may reseed the area naturally, but it is well to give the ground a good harrowing to cover the seed and properly scatter it. A top-dressing with clover straw or with manure made from clover hay will also tend to thicken up the stand by reason of the seeds which are present therein. Although no definite experimental evidence is at hand it is probable that by leaving occasional uncut strips of red clover across the field when cutting the seed crop this will furnish sufficient seed to reseed the ground when harrowed across the narrow uncut strips. [For red-clover hay, see "Haymaking," in another part of this volume.]

Red Clover for Ensilage.—Red clover may be so readily utilized as pasture or hay that as a rule to ensile it is not advisable; but if inclement weather ensues at the time of cutting for hay it is often advisable to ensile if the facilities are at hand. To make an ideal ensilage the crop should be cut a little earlier than is customary when cutting for hay, but early cutting is usually impracticable if hay is preferred, as the crop will be left uncut several days awaiting favorable haying weather. Although the uncured plants are heavy to handle to ensile them presents the advantage of retaining all their leaves. If sweet silage is desired, it should be dried for an equivalent of three hours of good haying weather before being put into the silo. If a feed cutter is available the clover should be cut before putting it into the silo. The second crop of clover when ensiled is best if mixed with some of the grasses or with Indian corn. The pure red clover silage is apt to be slimy. The more thoroughly it is packed down in the silo when filling the less likely it is to spoil.

Red Clover as a Soiling Crop.—Where pasturing is impracticable, red clover is often used as a soiling crop—that is, cut and fed green to live stock. Use in this way reduces or eliminates the danger from bloating which attends the use of red clover as pasture. It makes a good early feed, is palatable, and from 6 to 10 tons of green feed per acre is not an unusual yield.

Red Clover as Pasture.—Red clover is a most excellent pasture for all stock, especially when they are growing. For pigs it should

be supplemented with a small grain ration, as this will induce much more rapid gains. The early growth of red clover is less nutritious pound for pound than when nearing or at the blooming stage, since in the early stages of growth it is high in moisture content, thus requiring the animals to eat relatively larger quantities. Furthermore, close early pasturing is injurious to the stand of clover.

Bloating.—When pasturing cattle or sheep on red clover, care must be taken not to pasture when the animals are very hungry, especially when the red clover is young and succulent or when wet with dew or rain, as bloating may result. Should bloating occur, several remedies are usually at hand which will afford material relief. A large bit, the diameter of a pitchfork handle, may be tied in the mouth; a piece of rubber tubing may be passed through the mouth to the first stomach; or, as a last resort, the animal may be tapped to allow the escape of gas. For this purpose a trocar, such as is used by veterinary surgeons, is best; but in the absence of this, a small-bladed knife may be used to make the incision about 6 inches in front of and slightly below the left hip bone. A straw or quill may be used to permit the escape of gas. Care should be taken not to allow the straw or quill to work down out of sight into the incision.

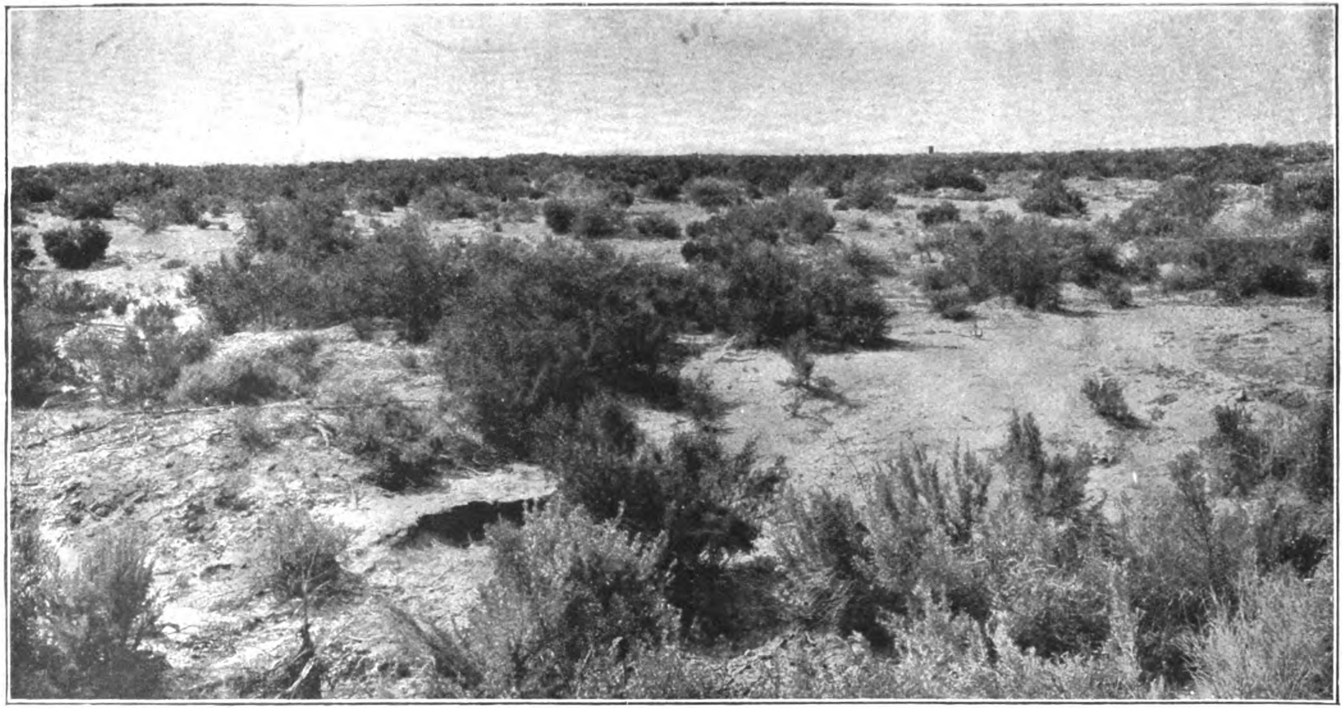
Red Clover as a Feed.—All farm animals require protein in some form in order to make their best growth or to produce the best results either in the form of milk and butter, as in the case of dairy stock, or as eggs, in the case of poultry. The ordinary roughage, such as corn stover and ordinary grass hay, is low in the necessary protein. On many farms this protein is supplied by feeding such concentrates as bran, oil meal, or cottonseed meal; but these concentrates are expensive and on most farms should be in large measure replaced by a leguminous forage crop, such as red clover, which can be grown on the place. Red clover is one of the most highly nutritious forage plants, either in the green state or cured as hay.

Red Clover in Mixtures.—For ordinary farm purposes it is very often advantageous to seed red clover in a mixture with other clovers and tame grasses. The root systems of different species are not the same, and as a result, the soils of both the upper and lower layers are more fully occupied than they would be by a stand of a single crop. In case the stand is to be used for pasture, the mixture will usually insure better succession of good pasturage than would the use of any single crop; that is, by proper selection of the constituents of the mixture it is possible to obtain a pasture which will provide for early as well as late grazing and at the same time give fair returns during the heated months of summer. Probably the most common mixture is red clover and timothy. In the Ohio River section and westward it is customary to seed the timothy with winter wheat and follow this up the next spring with red clover on the new stand of wheat when the ground is honeycombed by frosts. In the spring-wheat section the timothy is seeded with the red clover at the same time the wheat is sown. The timothy is longer lived than the red clover, and as a result the proportion of timothy in the

mixture of the hay increases very rapidly after the second season. Ordinary red clover matures about two weeks earlier than the timothy, and for this reason the Mammoth clover, being about two weeks later, is frequently used for seeding in mixtures with the timothy. Other mixtures suitable for hay are red clover combined with orchard grass, tall meadow oat-grass, and a small admixture of alsike clover. In any low places which may exist in the meadow it is advisable to replace the orchard grass with redtop and at least half of the red clover with alsike.

Effect of Red Clover on the Land.—The clovers have been justly ranked as the principal foundation of a permanent system of agriculture in the northern and eastern United States. By the proper utilization of the clover in the rotations it is possible permanently to maintain the supply of nitrogen and humus in the soil. The fertilizing value of red clover is not entirely in the hay which would be plowed under if the crop were to be used for green manure. Experiments show that 30 to 50 per cent of the fertilizer value of the clover may lie in the roots and stubble which are plowed under, even though the hay crop is removed. In one experiment the Delaware Experiment Station found that the red clover produced on an acre contained 122 pounds of nitrogen, 68 pounds of potash, and 28 pounds of phosphoric acid. At present prices for fertilizers one ton of clover hay contains nearly $10 worth of fertilizing elements. It frequently happens that the yields of grain crops are increased as much as 10 bushels to the acre by turning under clover sod, but too much must not be expected of red clover. The only real addition it makes to the land is the humus it supplies, together with the nitrogen it is able to extract from the air. The other fertilizer elements, such as potash and phosphoric acid, must needs be drawn from the soil itself.

Red Clover in Rotations.—One reason for the great popularity of the red clover plant is the ease with which it lends itself to the rotations which have been practiced in the sections to which it is adapted. The fact that it lives but two years necessitates a rather short rotation on the farm, especially when the clover is seeded alone. Meadows and pastures containing clover and grass mixed are usually held three or four years, even though very little clover may remain during the last year or two. The value of the red clover on the farm makes it usually desirable that a considerable area of the farm be at all times seeded to this crop. The possibility of obtaining a grain crop during the season when the red clover is making its early growth, makes the utilization of this legume in maintaining soil fertility a thoroughly practicable one, not calling for an undue amount of special preparation or fertilizers to maintain successful stands upon the ordinary farm. If the land be in a somewhat depleted condition as regards fertility a 3-year rotation with clover is best, although on better soils a 4-year or even a 5-year rotation may be practicable. The Illinois Experiment Station has shown as a result of a 30-year test that corn on land continuously has produced 25 bushels to the acre; corn alternated with oats, 43 bushels; while



Reclamation of Desert Lands, Native Vegetation, 1907.

corn, oats, and clover in a 3-year rotation gave a yield of 59 bushels for the corn.

Clover in Rotation with Corn, Oats, and Wheat.—A common rotation in the clover belt is corn followed by oats which in turn are followed by wheat. The wheat in turn acts as a nurse crop for the clover sown with it. After clover has stood two years the sod is plowed down for corn again. Rye may be substituted for wheat in the rotations already discussed. It has some points of advantage over wheat in that it grows taller and stools less and therefore does not shade the clover so much.

Clover in Rotations with Spring-Seeded Cereals.—In sections north of the winter-wheat belt it is usually the practice to seed the clover with spring-sown grain.

Rotations Containing Cowpeas or Soy Beans Preceding Wheat and Clover.—In sections where cowpeas and soy beans are successfully produced it is sometimes the practice to introduce one of these coarse legumes immediately preceding the wheat crop. The vines are either cut in time to have the ground ready for fall seeding or the entire pea or bean crop is rolled down and then cross-disked. The accumulation of the cowpea or soy bean stems and leaves on and near the surface serves as a mulch which acts very beneficially on the clover.

Seed Production of Red Clover.—The extensive production of red clover in this country is due to the production of a few acres on a large number of farms rather than to the production of large areas on farms devoted primarily to this crop. For this reason the clover crop is too often an incident and not the main issue on the farm. The various successful experiences of occasional farmers in sections where the average production of red clover seed is very low indicate that much is to be learned regarding the essentials of the successful production of the crop of red clover seed. Where these essentials are understood, it is usually not hard to provide for them and thus materially increase the seed crop. In practically all of the areas adapted to the production of red clover hay fairly satisfactory crops of seed are also produced. Red clover differs in this respect from alfalfa, which is grown for hay over extended areas where seed production is not practicable.

Handling Clover for Seed.—In order to produce the best crops of seed the conditions should be such as to retard somewhat the production of the largest vegetative growth, as the conditions which will produce a medium growth of the plant will usually induce the best set of seed. When the growth of the clover is so rank as to lodge, the heads are apt to be comparatively few and not well filled with seed.

Estimating the Probable Seed Crop.—Inasmuch as the clover straw is of little value as hay, if the crop is allowed to go to seed a decision must be made when the field is a little past full bloom as to whether the second cutting should be allowed to stand for seed or be used for hay. It is usually possible to estimate with fair accuracy the probable seed production by the time the plants are well out of

bloom. If examination of the field shows a uniform stand of a goodly number of heads with an average setting of 25 or 30 seeds to the head, it may be taken as an indication of a sufficiently good crop to pay for the seed, as under normal conditions this indicates a yield of 1 to 2 bushels per acre. If the heads which are turning brown show less than 20 seeds to the head, it will usually be better to cut the crop for hay even though it is a little too late for the best quality of hay.

Harvesting the Red Clover Seed Crop.—Under normal conditions the stand of red clover should be cut when the heads have turned dark brown and most of the seeds have reached the dough stage. If left much later than this stage the heads become brittle and break off in the process of harvesting. On the other hand, it is inadvisable to cut the clover when the seeds are in the soft dough stage, expecting them to ripen after cutting, as light, shriveled seed is likely to result. If the clover is a little overripe, the loss of heads may be materially reduced by cutting early in the morning or in the evening when the straw is less brittle by reason of the dew. The red clover should be cut as high as possible, as this will enable thrashing to be done with less trouble from the straw. Headers similar to or identical with the grain headers are sometimes used. Many farmers use a mower with a fingerlike attachment behind the cutter bar for bunching the clover behind the wheels, so as to be out of the way of the trampling of the horses on the next round. Another buncher is tripped by the foot, the guide rods pushing the hay partly to one side before the buncher is tripped. In the absence of such an arrangement, the ordinary mower may be followed by men who remove with barley forks the clover from the path of the mower and horses. An old-fashioned self-rake reaper is probably as satisfactory an implement as can be used. In many cases, however, no special devices are used to prevent injury by the mowing-machine wheels and the trampling of the horses.

Utilization of Clover Straw.—The clover straw after the seed has been removed from it is too coarse and unpalatable to be of much value as feed, though sheep and cattle will pick it over during the winter. It may be scattered back on the field with good effect on the land. The chaff may also be used as an absorbent of liquid in stables. It is an excellent plan to apply the clover straw and chaff to thin spots in the field which are to be in clover the succeeding year. This method materially improves the inoculation and tends to increase the productivity of the clover and other crops. If the clover is cut for seed and cured without having been rained upon, the straw has some feeding value, but such instances are unusual.

Enemies of Red Clover.—The principal enemies of red clover are insects, fungous diseases, and weeds. Occasionally burrowing rodents, such as mice and gophers, do some damage, usually not at all serious. Of the enemies just mentioned the insect pests are usually more troublesome than either the fungous diseases or weeds.

Clover-Sickness.—Some confusion exists regarding the nature of clover-sickness, a term which appears to have been applied to a

great many different causes of clover failure. In Europe this term is used to designate the condition of the land when it fails to grow continuous crops of clover but which will again grow successful crops after an interval of five to eight years. Such a condition would appear to be due either to the exhaustion of some particular element of fertility required by the clover, which would again become gradually stored up in the soil during the years when no clover was grown, or to the presence of some deleterious substance left in the soil by the clover plants, which is gradually eliminated from the surface layers of the soil.

Many sections in this country no longer grow clover as easily as it was formerly grown. Observations indicate that this failure to produce successful stands of clover is not due to any one particular cause but rather to a number of different causes, any one or any combination of which may react very unfavorably on the stand of clover. In some sections the cause of the frequently noted failures with clover has been specially determined. In Tennessee the presence of the clover anthracnose disease appears to be the principal feature in working against the production of this crop. In Illinois the lack of phosphorus and lime in the soil (often in connection with lack of proper drainage) has been pointed out as a predisposing cause of failure to get stands of red clover. In West Virginia the presence of nematodes on the roots has been observed to react unfavorably on the stands. In other sections failures have been shown to be due to lack of sufficient quantities of lime in the soil.—(Farmers' Bulletin 455, 1911.)

Varieties of Red Clover—Ordinary.—There are a number of varieties of red clover, each more or less adapted to some special purpose or to certain sections. Red clover (*Trifolium pratense*) is the most important member of the group of true clovers, although there are other important varieties and species. Under conditions where red clover succeeds it is the best general-purpose clover. It will usually produce both a crop of hay and a succeeding crop of seed in the same season. It has the further advantage of succeeding under ordinary conditions when seeded in connection with a grain crop, thus calling for very little extra labor when it is desired to establish a stand on the farm.

Mammoth Clover.—Mammoth clover, also known as Sapling clover, Pea Vine clover, Bull clover, and Perennial clover, is only a form of the ordinary red clover and is not sufficiently distinct botanically from *Trifolium pratense,* the ordinary red clover, to receive a botanical varietal name. It is not the "zigzag clover" of northern Europe, known as *Trifolium medium,* which latter name has often been misapplied to Mammoth clover. Mammoth clover is about two weeks later in maturing than the ordinary red, and it is partly owing to this fact that it is impracticable to harvest both a hay crop and a seed crop the same season. Mammoth clover is useful in seeding with timothy for hay, because it and the timothy bloom at the same time, whereas ordinary red clover blooms too early for the best results in cutting the timothy. The large size

of Mammoth clover plants makes them of slightly greater value as a soil improver, and in addition the seed yield is usually larger. The one crop of Mammoth clover is somewhat less than the two crops of ordinary red clover, but may be more economical owing to the greater cost of harvesting two crops of the ordinary clover. On low ground the stems of Mammoth clover are apt to become somewhat woody. It grows less rank on poor soils, where it is ordinarily grown, rather than on the heavier soils. Furthermore, on the poorer soils it is excellent as a seed-producing crop, being used in a rotation of corn, grain, and clover, each one year; the Mammoth clover is allowed to stand for seed and no attempt is made to utilize the hay other than for returning fertility to the land. The variation in the time of maturity of this clover enables it to avoid many of the insect pests which greatly injure the fields of ordinary clover. This item is important in reducing the injury from many of the insects which play havoc with the successful production of seed of the ordinary red clover. The seed of the Mammoth clover is slightly larger than, and is recommended above, either the ordinary or alsike on poor sandy lands in the North.

Other Species; White Clover.—The low-growing, shallow-rooted white clover (*Trifolium repens*) is adapted only for pasturage, as it does not attain sufficient height to be mown for hay. The seed crop matures in July and August in the Northern States. Yields of seed vary from 2 to 6 bushels per acre, and the price is about the same per bushel as that of red clover. A 2-year rotation of barley one year followed by white clover for seed the second is common in central-eastern Wisconsin. Elsewhere it is usually seeded in a mixture with blue grass and rarely if ever causes bloat as red clover is apt to do.

Giant White or Ladino Clover.—A tall-growing variety of white clover (*Trifolium repens* var. *lata*), first experimented with in this country by the North Carolina Experiment Station, was procured in Italy and may be imported thence in limited quantities. It grows several times taller than the ordinary white clover but not so tall as either the alsike or the ordinary red clover. It furnishes an excellent yield of good pasturage and makes sufficient growth to be cut for hay. The stems grow prostrate and only the elongated leafstalks and leaves are used for hay, which is a very nutritious feed but is somewhat hard to cure.

Alsike Clover.—Intermediate in general appearance between the white and red clovers, and erroneously supposed to be a hybrid between the two, is alsike clover (*Trifolium hybridum*), also called Swedish clover. Alsike is especially adapted to wet soils and also to soils which are too low in humus to grow red clover to advantage. Seed may be taken from the first crop, although an early clipping (especially if the spring is unusually wet) will usually result in a better crop of seed. The blooms are excellent as honey producers. In comparison with red clover, which lasts only two years, the alsike lasts for three to five years or even longer. The seed is much smaller and 4 to 8 pounds per acre is an ample seeding. The hay is some-

what richer pound for pound than the ordinary red clover, but only one crop is procurable and this is not generally as heavy as even the first crop usually produced by the ordinary red clover. It is hardier than either the Mammoth or ordinary clover, but lodges worse than either. For this reason it is usually best to seed it in mixture either with ordinary red clover or with orchard grass to prevent its lodging. In some sections where red clover is no longer grown successfully the farmers have been forced to adopt the alsike. The continuous use of pure alsike clover either as pasture or as hay has a tendency to produce sores on both horses and mules.

Crimson Clover.—Crimson clover (*Trifolium incarnatum*) is especially adapted as a cover crop and for green manure in the Atlantic States. It is easily recognized by its scarlet blooms. It is seeded in August either alone or in corn. Its special advantage lies in that its autumn, winter, and early-spring growth is sufficient so that it may be turned under in the spring following the seeding in time for another crop, such as corn or even cotton, in the South Atlantic States. It is also valuable for pasturing, soiling, or for ensilage, coming at a time when other green feed is scarce. One disadvantage in feeding the hay if cut when overripe is the tendency of the hairs, which are numerous on parts of the plant, to form hair balls in the alimentary tract of horses.

Shaftal Clover.—Shaftal clover (*Trifolium suaveolens*) has recently been obtained from Persia and is not yet on the market in commercial quantities. It is usually seeded in the fall and is somewhat similar to crimson clover in its requirements and growth. The seed is as yet very expensive. Moreover it lodges badly and is difficult to cure. These disadvantages handicap its more extensive production. Ordinarily this clover is a winter annual, maturing seed and dying the first summer after seeding; but a perennial strain is reported as growing in northern India.

So-Called Clovers; Sweet Clover.—Sweet clover (*Melilotus alba*) is often regarded as of little or no value as a forage crop on account of its bitter taste; but stock may acquire a taste for it, and then it proves a very satisfactory feed. It will grow on clay hills, on sandy stretches in the clover section, and also makes a satisfactory growth in sections where it is too dry to grow red clover. It is a biennial, living only two years, being similar in this respect to red clover. A permanent stand may be maintained by dividing the pasture and alternately grazing and mowing the two halves.

Lespedeza, or Japan Clover.—Lespedeza (*Lespedeza striata*) is distinctly a southern plant and makes very small growth north of the latitude of Virginia. In the extreme Southern States it makes a growth comparable with the true clovers and is a useful plant to supplement the winter-growing clovers which do not thrive in the hot summer months as does lespedeza.

Mexican Clover.—Mexican clover (*Richardsonia scabra*) is not a true clover nor even a legume. It occurs principally along the Gulf coast in the Southern States. It grows spontaneously after cul-

tivated crops are removed, being usually associated with crab-grass. The seed is not usually on the market.—(Dept. Agr., Farmers' Bul. 455.)

CRIMSON CLOVER.

The peculiar value of crimson clover is due to its being a winter annual, sown from the middle of July until late in the autumn. It is especially adapted for sowing in corn and similar crops at the time of the last cultivation, furnishing a cover crop during the winter and preventing washing on light lands. In common with the other clovers it is valuable as a soil improver. The hay is of good quality, if cut just as it comes into flower. If allowed to stand till nearly ripe before cutting, it is of little value, and especially dangerous to feed to horses. As the seed ripens, the barbed hairs in the seed head become stiff and hard, and numerous cases are known where horses fed on ripe crimson clover hay have died from the hairs forming large balls in their stomachs. Crimson clover is distinguished from the other cultivated clovers by its long head of brilliant scarlet blossoms and its erect habit of growth. It grows throughout the milder weather in winter and quickly makes a dense cover to the ground in spring. This can be pastured, cut for hay, or turned under for green manure, depending upon conditions.

In connection with the comparatively recent introduction of crimson clover as a forage plant and green manure in the United States, the following records of the injurious effect of crimson clover hay under certain conditions will be of interest, and will, it is hoped, enable farmers to avoid serious losses through carelessness in the use of this crop. With a letter a correspondent forwarded to the Department a ball of peculiar appearance, stating that it had been taken from the stomach of a horse which had been eating crimson clover (*Trifolium incarnatum*), and the death of which was ascribed to the presence of the ball. The statement was also made that a horse from which two similar balls were taken had been lost a few days before. During the preceding year several horses had died in that vicinity under similar conditions, as many as thirty balls having been taken, it is said, from the stomach of a single horse. The Department wished to learn positively whether the balls could have been due to the feeding of crimson clover and whether any preventive could be recommended. About the same time another letter, from an entirely different locality, was received by the Department, accompanied by a ball taken from the stomach of a horse immediately after death. The statement was made that the horse had worked as usual without any signs of disease up to the time of its fatal illness. The horse was suddenly taken with intense pain and lived only five hours. Another ball similar to that taken from the stomach was found in the large intestine. Several other horses in the vicinity had died the preceding week, all apparently from the same cause, and the farmers had ascribed it to the feeding of crimson clover.

Though crimson clover has long been in use in Europe as a forage plant, nothing appears to have been published there regarding its liability to form hair balls, and nothing, therefore, regarding

treatment of cases. When the balls have once developed to such a size that they can not pass through the intestine no practical remedy can be suggested. But the prevention of the difficulty is in most cases easy. The hairs of crimson clover do not become stiff until the plant has passed the flowering stage and begun to ripen. It should be made a rule, therefore, never to feed crimson clover after the crop has ceased flowering, and especially never to follow the pernicious practice of feeding stock with the straw of crimson clover raised and thrashed as a seed crop. By guarding against improper methods of feeding there is no reason why crimson clover should not continue to maintain its well-merited reputation and increase in use as a forage plant and green manure.

The seed of crimson clover is larger than that of red or mammoth clover and is almost perfectly oval in shape. The fresh seed is of a bright, slightly reddish or greenish yellow color and has a high polish. As the seed becomes older, the color changes to a reddish brown, and eventually the polish is lost and the seed has a dull, dark, reddish-brown color. Dark seed should never be purchased, as it is too old to grow.—(Dept. Agr. B. P. I. Circular No. 8.)

This plant is by no means new. It has been tested by many persons on a small scale with very variable results. The main difficulty appears to be its inability to withstand our severe winters. Perhaps two-thirds of those who have tried it report a complete or partial failure, while the remainder seem to be very enthusiastic over their success. A strip sixteen rods long by one rod wide was sown together with some rye for protection. It germinated nicely and before winter set in was 5½ inches high. The winter was a comparatively open one; other clover and grass lands heaved and froze out badly. Regardless of these conditions about 22 per cent. of the plot came through all right. Where it did come through the winter, it looked well, stood on an average 18½ inches in height, and made a fine crop. Crimson clover is also known as scarlet clover and Italian or German clover. It is an annual, requiring seed for each crop. The flower heads are bright crimson in color and from 1½ to 2 inches long. The plants attain a height of from 12 to 26 inches.

Time to Sow.—The general impression is that it has not proved hardy enough to fully withstand the winters of New Hampshire. In Delaware, where 2,340 acres were sown in 1891, it was planted the latter part of July or during August. This crop may be cut for silage or hay early in May and a yield of from one to two tons per acre may be secured from very poor land. The plants from the seed sown in August blossomed during the latter part of May. It is claimed that if it is sown in July it will make a growth by fall, which may be used for pasture during October and November, as a good substitute for hay.

The seed weighs sixty pounds to the bushel and from ten to sixteen pounds are necessary to seed an acre properly. It is claimed that there are five types of crimson clover, and that but one of these is hardy.—(N. H. Agr. Exp. Sta. Bul. 37.)

Value.—The value of the crimson clover crop depends largely on the quality of hay harvested, and this in turn on the manner of curing. The methods employed in the making of crimson clover hay are not unlike those practiced in curing red clover hay or cowpea hay. Under the most favorable conditions crimson clover will require considerable attention in curing. May weather conditions are likely to be rather unsettled, including much rain and a comparatively low temperature. The weather conditions, however, are as favorable for handling crimson clover as for cowpeas. It will be noted from the table that the average precipitation and temperature for September are nearly the same as for May. The general practice is to cut when the dew is off, allow to wilt thoroughly, but not long enough for the leaves to snap, throw into small cocks built high on a small base and leave standing for several days. The most of the curing and sweating is done in the cock. Just before housing the cocks are turned over and opened so that the hay may be thoroughly aired.

The hay tedder will be found a very efficient appliance in handling a heavy cutting. More even curing is possible by this method. The tedder is started soon after the mower and the clover turned as often as the time will permit. This hastens curing and the hay may be put in cocks earlier and more evenly cured.

Hay caps of oiled muslin or canvas material would undoubtedly be of advantage in handling crimson clover hay. These, while rather expensive, may be used for many years with proper care. The stage of maturity at which to cut is important, inasmuch as it largely determines the quality, as well as the ease of curing. If cut too early, more difficulty will be met with, as the plant then contains the maximum moisture content. If cut too late, the hay will be more readily cured, but will likely be less palatable on account of the greater amount of crude fiber. As mentioned above, while discussing the feeding value of crimson clover, injury may follow the use of the over-ripe hay. The blossoms of crimson clover begin to open at the base of the spike, and as the lower part of the spike becomes faded the plant is little past the middle stage of the blossoming period. Most of the replies to the question regarding the stage of maturity for cutting, state that full bloom is the time to cut for best results.—(Del. Agr. Exp. Sta. Bul. 89.)

ALSIKE CLOVER.

This plant (*Trifolium hybridum*) is a perennial clover, in size and appearance intermediate between red and white clover. It is adapted to more moist ground than red clover and is recommended as a constituent of wet pastures. In some localities farther north it does better and is a more certain crop. It will supply about as much pasture as red clover, is seeded at the same time, and furnishes pasture for the same period. As a hay crop it will not yield as much, but it is a little better than red clover, as it does not have as woody a stem.—(Dept. Agr. B. P. I. Bul. 111.)

This clover is well and favorably known and widely cultivated in mixtures for meadows and pastures, especially in low and wet

marshy ones in the Middle and New England States. In the South it is not so successful, nor so highly valued. This clover will thrive where the soil is quite wet, and will even stand flooding without being killed, whereas red clover is quickly destroyed by stagnant water. The foliage is slightly bitter, and it is not relished by cattle as well as that of the red and white clovers. The seed is much heavier than that of any of the other clovers, varying from 94 to 100 pounds per bushel. It is never advisable to sow this clover alone, because a better and larger amount of forage is produced when it is grown with grasses. Red top and alsike are as much a standard mixture for wet meadows as timothy and red clover for the better and drier uplands.—(F. B. 166.)

The seed is sold under the name alsike clover and sometimes with the additional names hybrid clover and Swedish clover. The identity of the sample is easily recognized through its mixed green colors. Individual seeds have much the same form as those of white clover, although in some specimens the extremity of the caulicle is relatively more prominent. The colors of the seeds vary from yellowish green to very dark green. The lightest specimens are uniformly colored. The darker colored ones are usually lightest about the scar-bearing extremity, and many of them are mottled with spots of light green. The surface of the lighter seeds is smooth, while that of the darker ones is often finely uneven or roughened All are comparatively dull. Specific means of adulteration do not seem to be employed beyond the use of very weedy, or low-grade, seed of the same kind. Other clover seeds are too light colored to escape detection.

WINTER BUR CLOVER.

This plant is gradually taking the commons and roadsides at many places in Texas, growing on all grades of land from the poor sands to the stiff, black waxy lands. The bur clover has two species growing in this country, the *Medicago denticulata* and *Medicago maculata,* or spotted leaf kind. The former, also called California clover, is most generally found in Texas. It is growing about almost all the towns from Houston to Dallas. The other kind the writer has seen at Palestine, Jacksonville and Nacogdoches. As the name "Medicago" would indicate, bur clover is closely related to alfalfa instead of the true clovers. While alfalfa, being mostly a summer grower, requires choice land and almost ideal conditions, bur clover grows in winter and early spring, and will thrive on any kind of land with rainfall enough to bring up the seed in the fall, and without any particular effort in the way of preparation. Alfalfa will probably not grow profitably on the great majority of rather thin, sandy or clay uplands of East and South Texas. Bur clover is perfectly at home on these locations after once getting a start.

Nutritive Value.—This plant is probably equal to alfalfa in nutrition; but since it completes its growth and dies by April or May, it is not generally considered of much value for hay. It would give only one crop of hay, and that not a heavy one. Therefore, it is generally grazed through winter and early spring. It is not relished es-

pecially by stock, and when they can get other grazing, they often pass it by, thus leaving the impression on people sometimes that stock do not eat it. As a matter of fact, they do eat it, and at a time when there is little else to eat, and it is very nutritious. In East and South Texas and other localities having about the same climate, bur clover always gives good grazing from one to two months before Bermuda and other summer grasses are ready. It thus enables us to almost fatten cattle before flies, heat and other annoying conditions appear. As grazing for dairy cows, it materially lightens feed bills, and in a large measure compensates for the lack of silage, one of the best and cheapest dairy feeds to be had.

For hogs it affords good grazing from November to May, say full half the year, and the grazing is just as nutritious, according to chemical analysis, as alfalfa. Alfalfa probably does not afford grazing more than eight months in the year, and yet it is one of the greatest pork-producing crops known, when grazed in connection with light corn feeding. An acre of alfalfa has often produced pork enough to pay for the corn consumed, and from 500 to 750 pounds besides. With plenty of winter and summer grazing, and a little corn feeding, hogs have often been produced for from 2 to 2½ cents a pound, while hogs raised and fattened on corn alone probably cost in the neighborhood of 10 cents a pound. It should not be forgotten, however, that no grazing crop alone will make hogs grow rapidly without some grain or other concentrated food in connection with it.

Bur clover on Bermuda grass is the finest kind of combination for an all-the-year-around pasture. The clover grows in winter, while the Bermuda is dormant, and in the early spring before the latter gets a start. The grass sod holds up the stock while the clover is being grazed. The clover dies root and top in time to begin to rot and fertilize the soil by the time the weather is warm enough to start the grass. The nitrogen gathered from the air by the clover, and gradually given to the grass through the summer as the clover stems, roots and leaves rot, makes the grass larger, greener, tenderer and more nutritious.

Before the clover dies in spring, it makes a great quantity of burs, containing the seed, from 50 to 200 bushels per acre, and these are left on the ground to come up again in the fall, which they never fail to do when the fall rains come, and without any further preparation of the land whatever. If, for any reason, the land is plowed or harrowed or otherwise treated, it makes no difference—they come up anyhow. The writer has seen old bur clover land planted in cotton or other hoed crops, and yet the bur clover would continue to come up each fall for three years.—(Texas Agr. Exp. Sta. Bul. 108.)

LESPEDEZA, OR JAPAN CLOVER.

Lespedeza, or Japan clover (*Lespedeza striata*) is a native of eastern Asia that was first found in this country in central Georgia in 1846. It has spread since then so that it now covers more or less abundantly the whole area from central New Jersey westward to central Kansas and southward to the Gulf of Mexico. There is reason to believe that it has now reached nearly the limits over which it

will spread naturally. A common belief exists in the South that the plant was first introduced during the Civil War. This is erroneous, though it is doubtless true that the spread of the plant was greatly increased during that struggle by the movements of cavalry. Lespedeza is a summer annual that begins its growth in the middle part of spring but does not reach maturity until September and October. It is sometimes confused with the yellow-flowered hop clovers, but is readily distinguished by its purplish blossoms, which do not appear till August or later, while the hop clovers bloom early. Over most of its area it grows only 4 to 6 inches high, and there has thus arisen the common idea that it is adapted only to grazing. Under favorable conditions, however, especially in the lower Mississippi Valley on certain soils, the plants grow commonly to a height of 12 inches, frequently reaching 18 inches, and in exceptional cases 24 to 30 inches. Where the stand is very thin the plants have a prostrate habit, but where it is thick they grow upright, and the yield of hay from such plants is large, often exceeding 2 tons per acre and exceptionally reaching 3 or even 4 tons per acre. Under such conditions lespedeza is a crop of very high value, which has become more and more appreciated in late years, so that many farmers now employ it in regular rotations. It is not improbable that a wider knowledge of the merits of the crop will cause it to be more generally cultivated and perhaps over a considerably wider area. Lespedeza grows during practically the same season as certain other leguminous forage crops; i. e., cowpeas, soy beans, velvet beans, and beggarweed. Its desirability in any particular place will depend upon its ability to compete with the above mentioned crops.—(Dept. Agr. F. B. 441.)

The fruit is a one-seeded pod, which readily becomes separated at the point of attachment to the stem. The seeds are not threshed from the pods. It is not necessary, and it would be a difficult matter to accomplish. Because of these adhering pods, the seed seem light. Well-cleaned seed weigh twenty-five pounds per bushel. They are so small, however, that one bushel will give plenty of plants to make a good crop when properly sown. Soil inoculation by artificial means does not seem to be necessary anywhere. Possibly the crop would be improved by inoculation. It is a good soil-renovating crop. It belongs to the family of plants that take nitrogen from the air. Where it has been tried, there is universal testimony to its great value as a fertilizer. Some advantages of the lespedeza crop need to be especially stressed.

It perpetuates itself on the land by the annual seed crop. If the crop is harvested quite early, a second growth makes a crop of seed. If harvested late, seed are matured before harvest and shattered on the land in harvesting.

No hay crop allows such a wide period of time in which harvesting may be done. The harvest period may extend from late August to late October, including hay and seed crop. In fact, new lespedeza hay begins to come to the Baton Rouge market in late July. Such early cutting, however, will not yield a large crop, although the quality is excellent, as there are no leafless stems. While, under favor-

able seasons, a second cutting may be secured, it will be short, either for seed or for hay, and should continued dry weather follow such early cutting, the stand may be seriously damaged. It is not improbable that with a better understanding of the plant we will make two cuttings per season, when the most favorable conditions of growth prevail.

Lespedeza matures for the harvest in September and October, when there is generally fine hay-making weather.

It cures very quickly, since the stems are very small and contain a low per cent of water. Probably no other hay plant is so easily and quickly cured.

The climate of Louisiana seems to specially favor the growing of lespedeza. When the seed is sown in February or March, nature usually supplies adequate moisture to insure germination. Being sown on oats as a nurse crop, the delicate plant is protected from the severe frosts that sometimes visit us in early spring. During spring and summer, the warm sun and occasional rains do much to hasten the growth, and then comes the fall, with pleasant, clear, dry weather in which to gather the crop.

The adaptability of soils to lespedeza-growing is shown most beautifully by the vast amount that grows voluntarily from year to year. Anywhere, on the roadside, in the fence corner and even on the hardest, driest hills, the little plant shows itself, and very often under adverse conditions makes a wonderful growth. Probably, however, the lighter soils are best adapted to its growth. In them there does not seem that tendency to excessive growth of strong grasses and obnoxious weeds that is seen in the heavier black clayey soils and river bottom lands.

Lespedeza, like other legumes, cannot stand too much water, and while the fields should be well leveled and smoothed for the binder and mower, the drainage of the land should be perfect, and no low places that will accumulate water should be in the fields.—(Louisiana Agr. Exp. Sta. Bul. 130, 1911; Farmers' Bulletin 455; Del., B's 67 and 86; Mo. Cir. 42; Iowa B. 88; Cornell B. 294; La. B. 130; Nev. B. 47; N. D. B. 65; Ohio B. 142; Geneva, N. Y., B. 270. Also some of those already quoted.)

THE SOY BEAN.*

The soy bean, also called the "soja bean," as a forage crop, has become of importance in the United States, especially southward. It has been tested at most of the State Agricultural Experiment Stations and it appears that its region of maximum importance will be a little south of the red-clover area and in sections where alfalfa will not do so well. Generally speaking, the soy bean requires about the same temperature as corn. The soil requirements are much the same. The bean will make a satisfactory growth on poorer soil than corn, provided inoculation is present, but will not do so well on poor soil as cowpeas. The soy bean requires a well-drained soil for its best development. It is also decidedly drought resistant, and but for the depredations of rabbits would be a valuable crop in the semi-arid West. Rabbits are exceedingly fond of the foliage, and where they

*For illustrations, see pages 627 and 645.

are numerous it is nearly useless to plant the soy bean unless the field can be enclosed with rabbit-proof fencing.—(F. B. 372.)

Varieties of Soy Beans.—At the present time seven varieties of the soy bean, Mammoth, Hollybrook, Guelph, Ito San, Buckshot, Ogemaw, and Wisconsin Black, are handled by American seedsmen. During recent years more than two hundred additional varieties have been introduced from China, Japan, and India, most of which have already been sufficiently tested to give some idea of their value. Many of the new varieties are so superior in various respects that they are certain to replace all of the above-named varieties except the Mammoth and perhaps the Ito San.

The matter of variety is of special importance to the soy bean, as many growers have been sorely disappointed in getting a small early variety when they desired a larger and later sort.

Mammoth (*Yellow*).—The Mammoth variety is the largest growing and latest of the soy bean varieties at present handled by seedsmen. Under average conditions it will grow from 3 to 5 feet high, depending principally on the character of the soil. Ordinarily it requires from 120 to 150 days to mature a crop of seed. The Mammoth yields well in both grain and roughage and is satisfactory for both. It is a most exacting variety about depth of planting, and under no circumstances should the seed be planted more than two inches deep. The habit of growth is such that it can readily be harvested. This is a southern variety and will mature far north of Tennessee.

Hollybrook (*Yellow*).—The Hollybrook variety is about two weeks earlier than the Mammoth and seldom grows to a greater height than 3 feet. It is very coarse and not desirable for hay, but yields large crops of grain. The seed is nearly identical with that of the Mammoth. The lower branches and pods are apt to be very near the ground. It can be grown farther north than the Mammoth, but is not so valuable a variety.

Ito San (*Yellow*).—The Ito San soy bean has been very commonly grown, appearing under the names "Yellow," "Early Yellow," "Medium Yellow," and "Early White," as well as "Ito San." The plants are of medium size, averaging about 30 inches in height, with numerous ascending slender branches, so that this variety can be mown very satisfactorily. It has fine stems and makes excellent hay, though the yield is only moderate. It produces seed fairly well and matures in from 95 to 100 days.

Guelph (*Green*).—The Guelph soy bean has been advertised more than any other variety, appearing with such names as "Medium Green," "Medium Early Green," and "Large Medium Green." It grows about as large as the Hollybrook variety and matures about 10 days later than the Ito San. The leaves drop without changing color when the plant ripens. The plant is very coarse and not satisfactory for hay.

Buckshot (*Black*).—The Buckshot is a very early variety. It is also called "Early Black," "Extra Early Black," "Medium Early Black," and "Large Black." It seldom grows more than 24 inches

high and is at least a week earlier than the Ito San variety. The seed is considerably larger than ordinary buckshot, but has the same shape.

Ogemaw (*Brown*).—The Ogemaw is even earlier than the Buckshot variety and is also a small grower and less satisfactory. The seed, which is about the same size as that of the Buckshot variety can sometimes be purchased from northern seedsmen.

Wisconsin Black.—The Wisconsin Black is an early black-seeded variety that is grown to some extent in Wisconsin and Michigan. Its earliness is its principal merit. The following new varieties are the best out of more than one hundred sorts tested.

Wilson (*Black*).—The Wilson is a tall variety, growing 3 to 4 feet high, with few erect branches, maturing about one week later than the Ito San. Owing to its tall habit and lack of basal branches it can be harvested easily. It is a heavy grain yielder and also excellent for hay.

Meyer (*Mottled Black and Brown*).—The Meyer variety is excellent for hay, as it is tall and has fine stems and branches. It has given larger yields of seed than any other variety under trial at the Arlington Experimental Farm in Virginia.

Austin (*Greenish Yellow*).—The Austin is a vigorous though not coarse medium-late variety, growing 3 to 4 feet high, with numerous branches but none close to the ground. It can be easily harvested with machinery and is an excellent seed producer.

Haberlandt (*Yellow*).—The Haberlandt variety requires about one week's more time in which to mature than does the Ito San. The seed is considerably larger than that of any of the other yellow-seeded varieties and has a distinctly brown hilum, or seed scar. It is a heavy yielder of seed, but is rather stocky, seldom growing to a greater height than 30 inches.

Riceland (*Black*).—The Riceland is a soy bean which requires a very long season in which to make its full development, and is therefore adapted only to the cotton belt. The seed is rather small, long, and flat, and covered with a powdery bloom which makes it look dusty. The plants grow from 4 to 6 feet high, but have fine stems and consequently are of a very desirable type for hay.

The Culture and Planting of Soy Beans.—Good preparation of the soil is necessary for soy beans; otherwise weeds are likely to choke out the young plants. This preparation should consist of deep plowing and subsequent working with disk and harrow until a firm seed bed, with the upper 2 or 3 inches loose and mellow, is secured. Under nearly all conditions the crop should be grown in rows and given sufficient cultivation to keep down weeds.

It is especially important to plant seed of good quality. Soy-bean seed unless it is fresh and has been properly stored is very apt to be low in germination. It should therefore be tested for viability before planting time. The planting should be shallow, preferably 1 inch and not to exceed 2 inches in depth. Poor stands result more frequently from too deep planting than from any other cause. A

bushel of good seed is sufficient to plant from 2 to 3 acres if in cultivated rows, and hardly enough for 1 acre if sown broadcast.

The cultivation of soy beans is a simple matter. Unless conditions are very unfavorable the seedling plants appear above ground in a week and tillage may then begin. Any good cultivator may be used, and flat cultivation is preferable, as the harvesting can be more easily done than if the rows are hilled or ridged. Soy beans may be planted through a wide period from early spring till midsummer. Ordinarily the bean is planted about June 1. In the lowlands of Tennessee and North Carolina and southward two crops of the early and medium varieties may be secured in a season. In general, early plantings require more time to mature than late plantings, the difference in the same variety often amounting to as much as three weeks.—(F. B. Bul. 372.)

The Inoculation of Soy Beans.—Like other legumes, the soy bean is able to utilize the nitrogen of the air and add it to the soil by means of root nodules. These nodules are caused by certain bacteria; unless they are present soy beans in the usual types of soil will make but a weak growth, and many of the plants will turn yellow and die. Throughout the South the proper bacteria for soy beans seem to be widely distributed, so that natural inoculation now occurs generally. In isolated localities where this crop has not been grown, however, some difficulty may be expected from lack of inoculation, during the first season at least. Northward and westward greater difficulty in this regard is experienced.

Inoculation of a new field may be secured either by the soil-transfer method or by the use of the pure cultures prepared by the Department of Agriculture, Washington, D. C. The soil-transfer method consists in scattering soil from an old, well-inoculated soy-bean field over the new ground at the rate of 200 to 300 pounds per acre. To facilitate even scattering this should be thoroughly mixed with several times its weight of ordinary soil. The soil may be either drilled or broadcasted. In the latter case it should be done toward evening or on a cloudy day, as bright sunshine is very harmful to the germs. The objections to the soil-transfer method are the labor and cost involved and the serious liability of spreading weeds and dangerous plant diseases. Successful inoculation by this method is, however, practically certain.

Soy-Bean Hay.—Soy-bean hay when cut at the proper stage of growth and carefully cured is excellent, and for dairy cattle at least yields results equal to alfalfa hay. For hay production soy beans may be planted in cultivated rows, or when the ground is free from weeds they may be drilled or broadcasted. The late or medium-late varieties are as a general thing best adapted for hay production. These varieties grow to a greater height and have finer stems and branches and more leaves than do the earlier sorts. Of the varieties now handled by seedsmen the best for hay production are the Mammoth and Ito San. The Mammoth variety makes a very large growth of plant, usually produces a large quantity of seed, and is well adapted for growing in the entire South. The Ito San is smaller,

with finer stems, and also yields satisfactory crops of grain. It is at least a month earlier than the Mammoth. Soy beans are not as a rule to be recommended as a hay crop north of the Ohio River, except in southern Illinois.

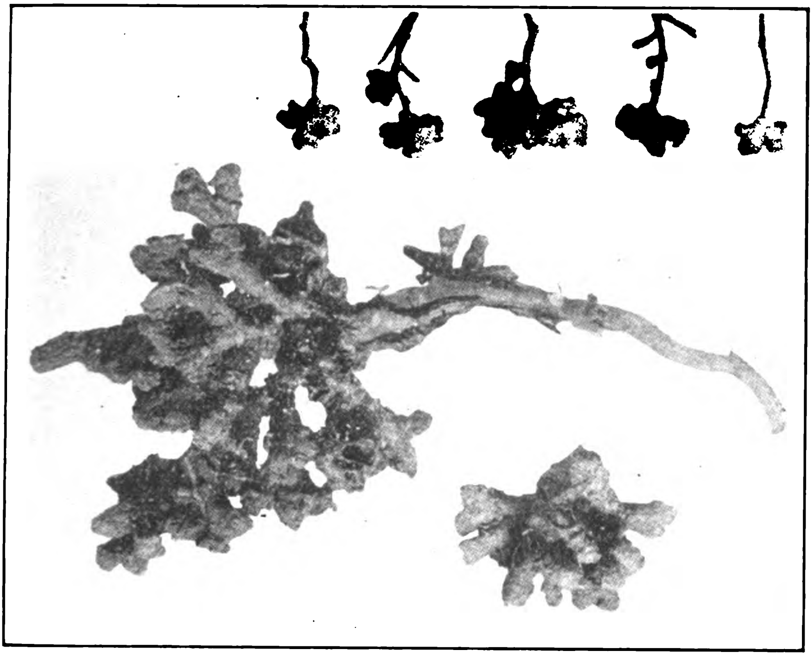
Curing the Hay.—The planting should be timed, so that the crop can be cut for hay in September, as this month is usually the most satisfactory for hay-making. The cutting may begin as soon as the dew is off the plants and continue for the rest of the day. The plants should be allowed to lie in the swath until the leaves are well wilted, but great care should be exercised to rake them before the leaves become dry and brittle. After raking into windrows they should be left for a day or two, depending on the weather, and then put in small cocks or bunches. Three to five or six days of good weather is ample time for making good soy-bean hay. Great care should be used to prevent the loss of leaves, since these are the most valuable part of the plant except the pods. When the hay is dry, it should be put in good-sized stacks or under a shed. If it is stacked in the open field it is very essential that some other material, either grass or a canvas cover, be put over the stack, as soy-bean hay does not shed rain well. Yields of from 1 to 3 and occasionally 4 tons of cured hay to the acre are secured. The average yield is about 2 tons per acre. Curing frames can often be used to good advantage in making soy-bean hay, especially in unfavorable weather. The object of these frames is to keep the cocks open, so as to prevent matting and to allow the circulation of air. They are usually three or four sided pyramids made of boards or poles 3 to 6 feet long, fastened together at the top and held by crosspieces near the base. By this device a hollow cock or shock is secured, and consequent better curing. In stacking the hay, poles or logs placed in the center of stack, so as to leave passages for air, will greatly lessen the danger of spoiling.

Soy Beans for Pasturage.—The soy-bean crop can often be profitably utilized by pasturing, particularly to hogs, especially when fed corn in addition. This is advisable when harvesting is interfered with by lack of labor, bad weather, or other causes and when the crop is grown especially for soil improvement.

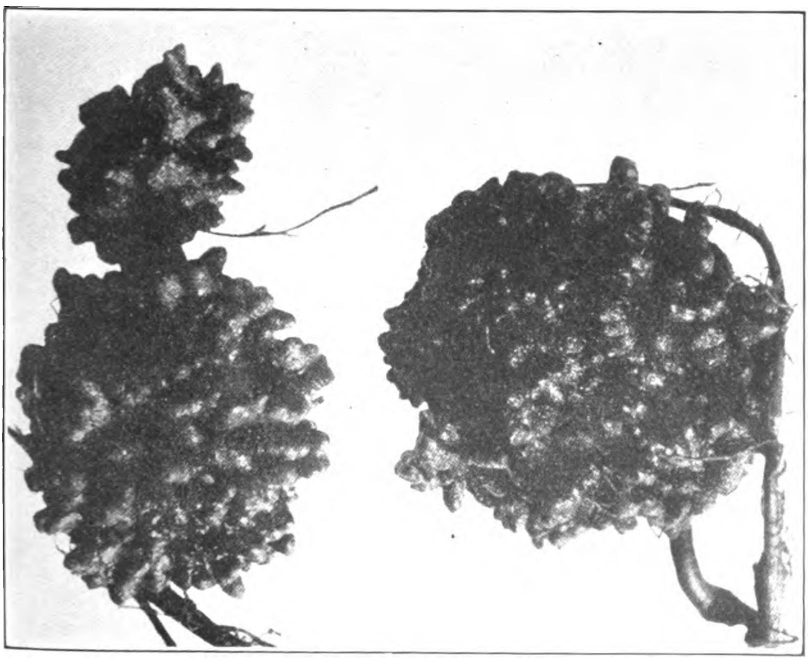
Soy Beans in Mixtures.—There has been but little experimenting as yet in growing soy beans in mixtures with other plants. What little has been done indicates that the bean may be satisfactorily grown in combination with a number of other agricultural crops.

Soy Beans and Cowpeas.—These two make a very satisfactory mixture for hay purposes. The tall, strong-growing varieties of soy beans are to be preferred for this combination, as the cowpea is a vining plant and needs something to hold it up so that it can be readily harvested. The hay of such a mixture is more desirable than the hay of either crop alone, as it affords variety. The yield also is nearly always greater. There is no doubt that most live stock prefer the soy bean to the cowpea in this mixed hay, but both plants are eagerly eaten by practically all kinds of farm stock.

In sowing soy bean and cowpea seed in mixture about 1 bushel



NODULES OF ENCEPHALARTOC HORRIDUS, YEAR BOOK, 1910.



VELVET-BEAN NODULES, YEAR BOOK, 1910.

of the former to a half bushel of the latter per acre should be used. If planted in rows, about one-half of this quantity of each is sufficient. It is necessary to have more soy-bean plants than cowpeas, so that the vining growth of the cowpeas may be supported properly. The Mammoth and Hollybrook varieties of soy beans are preferable. The Whippoorwill and Iron varieties of cowpeas are good.

Soy Beans and Sorgo.—The soy bean may be grown in mixture with sorgo (sweet sorghum). There is some objection to the mixture when broadcasted, as the sorgo is apt to choke out the soy beans. When grown together in cultivated rows, this objection is largely overcome. Amber sorgo is usually the best variety for use.

Soy Beans and Millet.—Some of the earlier varieties of soy beans have been grown with German millet. The mixture is not a good one, as the millet matures long before the soy beans.

Soy Beans and Corn.—Soy beans are more commonly grown with corn than with any other crop. They are planted in different sections in various ways, namely, in alternate hills with the corn in the same row, in alternate rows of each, in alternate series of two rows of each, or broadcasted in mixture. Such fields when planted in rows may be harvested for silage, or where the rows alternate the two crops may be harvested separately. Sometimes such mixed fields are utilized by pasturing to hogs. The early and medium varieties of soy beans may be planted in between the corn rows at the time of the last cultivation.

Soy Beans for Ensilage.—The growing of soy beans for ensilage has not been practiced very extensively. In a number of instances ensilage has been made of the crop, usually in combination with corn, and it is invariably reported as making an excellent succulent feed. Only the larger late-growing varieties are desirable for this purpose. Some have tried growing soy beans in the corn rows or between the corn rows, planting it the same as cowpeas are planted in the cornfields of the South, while others prefer growing corn and soy beans in separate fields and when the ensilage is put up to mix them in the cutting. Where the soil and climate will permit, it would seem to be more satisfactory to grow the soy beans in the cornfield. It is doubtful whether it will be economical to make ensilage of soy beans when hay can be made with comparative ease.

Soy Beans for Grain.—Growing soy beans for the grain for use as feed is distinctly profitable if the yield is 16 bushels or more per acre. The feeding value of the grain is very high, being slightly superior to cotton-seed meal. The grain is rich in protein, while nearly all the other grains produced on the farm are poor in protein, but rich in carbohydrates. For grain production tall varieties that do not branch or bear pods close to the ground are desirable, as they are more easily harvested. Of the varieties now on the market the Mammoth and Hollybrook are undoubtedly much the best for the South, while the Ito San and the Guelph, which is also known to the trade as Medium Green, are best for more northerly latitudes. A very serious objection to the Guelph, however, is its great tendency to shatter seeds at ripening time. When grown for grain alone, the

cutting may be delayed in the case of most of the varieties until all of the leaves have fallen. The Guelph and a few other varieties not on the market retain the leaves late and much seed would be lost by shattering if the harvesting were not done earlier. The plants should be allowed to become thoroughly dry after cutting before they are stacked or put into a barn or shed.

Soy Beans in Rotations.—Soy bean is admirably adapted to short rotations, taking either an entire season or a part of a season following some small-grain crop. In Tennessee and North Carolina a soy-bean crop is often grown between two wheat crops, and in other parts of the South between oat crops. In such cases, however, an early variety like the Ito San or the Haberlandt is preferable. Where a whole season is devoted to soy-bean two crops of the earlier varieties can be matured in all parts of the cotton belt, and this is in many cases preferable to growing a single crop of a late variety. Where the whole season is thus devoted to soy beans, it may take any place in a rotation system where corn can be used. The consensus of opinion among farmers is that a crop of soy beans benefits the succeeding crop, but not to so great a degree as one of the cowpeas. Regarding the fertilizer requirements of soy beans there are but few data available. Where fertilizers are used, the general practice is to use acid phosphate at the rate of 200 to 300 pounds per acre and muriate of potash at the rate of 50 pounds per acre.

Feeding Value of Soy Beans.—The feeding value of any forage crop and for any particular purpose can be determined only by actual feeding experiments. There are, of course, definite relations between the digestible constituents of a feed and the resultant gains in flesh or milk. These relations are, however, more complex than a table of analyses indicates. On this account the relative value of feeds is best shown by comparative feeding trials. Such trials indicate that good soy-bean hay is about equal to alfalfa for milk and butter production. They also show that soy-bean meal is somewhat superior to cotton-seed meal in the production of pork, mutton, and milk. Soy-bean meal also proves to be slightly more valuable than wheat middlings in feeding hogs.

Feeding Value for Sheep.—The Wisconsin Agricultural Experiment Station has tested the value of soy-bean seed for fattening lambs. In one experiment two lots of 10 lambs each were fed the same roughage. One lot received shelled corn and whole soy beans in equal proportions, while the other received the same quantities of shelled corn and whole oats. The average gain of each lamb during a period of twelve weeks was 16.3 pounds when soy beans constituted a part of the ration and but 13.7 pounds when oats were used. A pound of gain was produced on 6.11 pounds of grain and 7.11 pounds of roughage in the soy-bean ration, while 7.28 pounds of grain and 8.62 pounds of roughage were required on the oats ration. In another experiment the same rations were fed for twelve weeks to two lots of 9 lambs each. The lot receiving the soy-bean ration gained 119 pounds in weight and produced 95.1 pounds of wool, against 71 pounds increase in weight and a production of 81.3 pounds of

wool for the lot receiving the oat ration. The second lot also consumed more feed per pound of gain.

Feeding Value for Dairy Cows.—Soy-bean meal has been found a most excellent feed for dairy cows. The Massachusetts Agricultural Experiment Station compared soy-bean meal and cotton-seed meal, using the same ration otherwise. The quantity of milk produced from the soy-bean ration was slightly larger. The butter from the cows fed cotton-seed meal was of firmer texture, but not nearly as good otherwise as the butter from the cows fed soy-bean meal. The test indicated that soy-bean meal was superior to cotton-seed meal for both milk and butter production.

At the Tennessee Agricultural Experiment Station three groups of cows of two lots each were fed to compare (1) soy-bean straw and corn stover; (2) soy-bean hay and alfalfa hay, and (3) soy-bean meal and cotton-seed meal. There was no chance in these experiments for the individuality of the animals to affect the results, as each lot was fed on the separate rations at different periods in the course of the experiments. Soy-bean straw was found very palatable and superior to corn stover as a feed. More feed was eaten in the case of the soy-bean straw, but the cost of the feeds consumed during a thirty-day period was practically the same. The soy-bean ration produced 12 per cent more milk and 14 per cent more butter fat, so that the cost of a gallon of milk was 1.2 cents less and of a pound of butter fat 2.1 cents less than when corn stover was fed as roughage. In the comparison of soy-bean hay and alfalfa hay, these substances were fed in combination with corn silage and corn-and-cob meal. Each lot of cows consisted of four Jerseys, and the test lasted through three periods of thirty days each. At the end of this time the results were in favor of the soy-bean hay by 245 pounds of milk and 20.5 pounds of butter fat. This result indicates a slight superiority of soy-bean hay over alfalfa hay. In the trial for the comparison of soy-bean meal and cotton-seed meal the yield both of milk and of butter fat was about 5 per cent greater for the soy-bean meal.

Feeding Value for Hogs.—The Wisconsin Agricultural Experiment Station compared soy-bean meal and wheat middlings for pork production in three separate experiments in as many years. Two-thirds of the grain ration was corn meal in each case. In each of the experiments the largest gains were made on the soy-bean rations. Soy-beans proved about 10 per cent superior to wheat middlings for pork production, figuring the cost of the feeds as the same.

The Indiana Agricultural Experiment Station compared rations of 2 parts of corn meal and 1 part of soy-bean meal with corn meal and wheat middlings in equal proportions and with 5 parts of corn meal and 1 part of tankage for pork production. The soy-bean ration produced the largest daily gains, and this with the smallest quantity of feed consumed for each pound of gain.

The Kansas Agricultural Experiment Station has several times tested the value of soy-bean meal in combination with corn meal and with kafir meal in comparison with the two latter fields alone in feeding hogs. The feeds were mixed in the proportion of four-fifths

corn or kafir and one-fifth soy bean. Larger gains, varying from 13 to 37 per cent, were made in every case on the mixed rations than on corn or kafir alone. With corn meal alone 100 pounds of gain cost $3.92, with corn meal and soy-bean meal $3.73, and with kafir meal and soy-bean meal $3.37. For these computations the value of corn meal was fixed at $14 a ton, kafir meal at $13 a ton, and soy beans at $25 a ton, or 75 cents a bushel.

Storing Soy-Bean Seed.—The storage of soy-bean seed requires special care. The grain should be thoroughly dry when put into storage or else placed where good ventilation is afforded; otherwise it is almost certain to heat and be ruined as far as germination is concerned. No matter what may be the condition of the seed at the time it is stored, it should be examined occasionally to detect any tendency to heat. Even when soy-bean seed has been stored carefully the germination is apt to fall off rapidly. In fact, it is as a rule unwise to plant seed more than one season old without first testing it for germination. Unlike cowpea seed that of soy beans is rarely attacked by weevils.

Results of Tests of Varieties of Soy Beans.—The number of tests of varieties of soy beans conducted throughout the state in 1907 was 65. Of these 63 consisted of the regular sets of four varieties each. Most of the unsatisfactory reports resulted from carelessness and losses of parts of the crop at harvest time due largely to unfamiliarity with it.

The Dwarf Early Yellow, Ito San and Early Brown varieties are very similar in their general characteristics, and may be classed as medium in size and time of maturity. The average time of ripening is from the 10th to the 15th of September, or about 115 days from time of planting.

The Medium Early Yellow is a late maturing variety and probably suitable only to the South. At the station it ripens about October 20, or in about 150 days from time of planting. It usually requires a severe frost to ripen it. The freezing, however, seems to do little harm to the quality of the seed. This variety has relatively large plants, with long, slender stems and branches, and an abundant of foliage, making it the most suitable variety for feeding green or making into hay.—(Ind. B. 124, Vol. XIV.)

THE SOY BEAN IN HAWAII.

While possessing most of the good qualities common to other leguminous forage plants, the great diversity of type to be found in the soy bean adapts it to many uses and conditions unsuited to other legumes. Its chief characteristics are its heavy seeding and early maturity. Nearly all varieties are of compact and upright growth, with strong tap roots, and stiff stems which rarely show any tendency to trail, although some of the ranker growing varieties sometimes lodge. In nutritive value the forage compares favorably with any legume that can be grown, and the ground or crushed bean is said to be equal to the best and most costly concentrates that can be purchased for feeding purposes. Among its most important uses is that for culinary purposes, especially in the manufacture of the Japanese

products (soy and miso). These products are imported into Hawaii from Japan in large quantities, but their manufacture is being rapidly extended in Hawaii. This has created quite a demand for the bean locally. At present two and one-half million pounds of the bean are being imported into Hawaii annually. The average cost is about $3 per hundred pounds landed in Honolulu and the beans sell for from $3.25 to $3.40 per hundred pounds. The Japanese coffee growers in the Kona district in Hawaii have been growing the beans as an intercrop for a number of years. The total production is said to be about 200,000 pounds per annum. It will thus be seen that the immediate local demand is very far from being supplied at present.

Because of the great diversity of types available, the crop may be adapted to many forms of culture. Any crop that will permit of intercultures may have some variety of soy bean adapted to its need. Thus if it should be found advisable to intercrop the pineapple, sisal, coffee, rubber, or other crops during the unproductive periods, to help pay for the expense of maintenance, or as a direct aid in fertilization, the soy bean would be found to fill this need better than almost any other legume that could be grown. As a catch crop to fill in a short interval between two staple crops, its early maturity may give it advantages not possessed by other legumes.

While in a regular rotation it fills all the needs that can be supplied by any legume, its value as a green manuring crop would seem to be of equal value. It is more easily turned under than any other legume treated in this bulletin and rots more quickly than the coarser stemmed sorts. In Japan and other oriental countries this crop, to a greater extent than almost any other, is responsible for the remarkable maintenance of their soil fertility. At least one American grower in Hawaii has profited by these practices. His method is to sow the soy beans between various perennial fodder crops.

For the low, compact varieties seed may be drilled in rows 18 to 24 inches apart, but the tall, branching sorts should be planted at least 30 inches apart; 40 to 60 pounds of seed will be required to plant an acre, depending upon the size of the seed and the distance apart. As the soy bean shades the ground less than do most of the other legumes, it requires more cultivation to keep down weeds and conserve the moisture, and it will repay all reasonable tillage. If intended for green or cured fodder or silage, the crop should be harvested when the pods are half formed. If intended for seed, care should be taken not to delay the harvest too long, since most varieties shatter the seed very readily, with the result that much of the seed may be lost.

The yield of seed obtained by the station from small experimental plantings ranges from 600 to 1,000 pounds per acre from the dwarf early maturing varieties, and about twice that amount from the medium late and medium tall sorts. It seems very doubtful that more than a ton of seed per acre can be obtained under any except unusually favorable conditions. The yield of fodder from the heavy seeding varieties about equals or slightly exceeds the yield of seed. The ranker growing varieties have yielded at the rate of 4 to 8 tons

of green fodder per acre, which, while hardly equal in weight to that obtained from some of the other legumes, even during a corresponding period of growth, may, because of its greater nutritive value and palatability, more than balance the outcome.—(Hawaii Bul. 23.)

Summary.—(1) For intensive farming the soy bean is the best annual legume to grow for forage in the southern part of the cotton belt and in the southern part of the corn belt.

(2) The soy bean, whether used as hay, grain, straw, or ensilage, is very valuable as feed for live stock.

(3) Soy-bean hay is practically identical in feeding value with alfalfa and yields from 2 to 3 tons per acre. To make good soy-bean hay the crop must be cut when about half the pods are full grown or when the top leaves first begin to turn yellow.

(4) Soy-bean grain is more valuable than cotton-seed meal as a supplemental feed in the production of pork, mutton, wool, beef, milk, and butter. A bushel of soy beans is at least twice as valuable for feed as a bushel of corn. As the grain is hard it is usually desirable to grind it into meal for feeding. This is best done by mixing with corn before the grinding to prevent gumming up the mill.

(5) Harvesting ordinarily should be done when the leaves first begin to turn yellow, as the quality of the straw rapidly deteriorates thereafter and the yield of seed will be practically as large as at any later time. From 20 to 30 bushels of grain and 1½ to 2 tons of straw per acre are not uncommon.

(6) If soy beans are grown for the seed alone, and sometimes this is desirable, the harvesting can be done most easily by waiting until the leaves have fallen.

(7) Soy-bean straw, if the crop is cut before the leaves fall, is fully as valuable for feeding as timothy hay for cattle, and is eaten by stock with much relish. Even when the harvesting is delayed until all the leaves have fallen, stock will eat the straw readily.

(8) Mixed with corn, soy beans are excellent for ensilage. The two crops may be grown together, but it is usually better practice to plant in separate fields and mix when putting into the silo.

(9) It is necessary to give the soil thorough preparation in order to be successful with soy beans. Only fresh seed or seed which has been tested for germination should be planted. Two-year-old seed is usually not reliable. The seed should be planted shallow, not to exceed 2 inches in depth, and preferably in rows 30 or, better, 36 inches apart to permit sufficient cultivation to keep down weeds.

(10) For harvesting soy beans a mower with or without a side-delivery attachment, a self-rake reaper, or a self-binder can be used. A binder can be used only with the tall varieties. The thrashing can be done with a grain separator by using blank concaves and running the cylinder much slower than for small grains or by the use of machines specially designed for handling soy beans and cowpeas.

(11) Soy beans and cowpeas can be grown together satisfactorily; the hay of such a mixture is better than either crop alone and the yield is generally greater. In planting the two together the seed

should not be covered too deep, as deep planting will result in a poor stand of soy beans.

(12) As a crop in a short rotation soy beans are very desirable, They can be grown so as to use an entire season in the case of the late varieties, or two crops in one season can be secured from some of the earlier ones. They can also be used very advantageously to follow a small-grain crop the same season.

(13) The important commercial varieties of soy beans are the Mammoth, the Hollybrook, and the Ito San. Among the most valuable new varieties are the Austin, Wilson, Riceland, Meyer, and Haberlandt, most of which were in the hands of seedsmen in 1910.—(Farmers' Bulletin No. 372; Ky. B. 125; Va. B. 168; R. I. B. 92; Ohio C. 78; Kan. B. 92; Tenn. B. 82; also B. 23; Kan. B. 100; Mich. B. 224; Ind. B.'s 120 and 124 and many of those mentioned above.)

THE VELVET BEAN.

While this plant has been known in Florida for more than twenty-five years it received little attention prior to 1895. Until this time it had been used to a limited extent as an ornamental vine. The attention of the Florida Station was directed to the plant in 1895. It was shown that it had been used in one neighborhood about twenty years as a covering for trellises and unsightly places. Owing to the enormous growth the plant made it was decided to try it in an orange grove as a soil renovator, and the results were very satisfactory.—(Bulletin 35, Flor. Exp. St.)

Its Culture.—The velvet bean requires a long season in order to mature the seed; therefore, its cultivation will be confined to sections where the growing period is fully eight months. It will do well and mature the seed in Florida and the southern part of the Gulf States. The plant grows well as far north as Tennessee, but beyond southern Georgia it is necessary to purchase seed each year for planting.

In Florida the planting should be done in March or April. The quantity of seed to be used for planting an acre may be varied from one to two bushels. The planting may be broadcast yet it is better to plant in rows about four feet apart leaving a space of from one to two feet in the row. This admits of cultivation until the plants are well established and aids in freeing the land from objectionable weeds and grass, and so the resulting forage will be much better than otherwise. After the velvet bean obtains possession of the soil it shades the ground so completely that other plants are crowded out. If the soil is very thin it is well to supply some potash and phosphoric acid; the quantity to be added depends upon the condition of the land and the crop which is to follow the velvet bean. One hundred pounds of sulphate of potash and two hundred pounds of acid phosphate should prove ample in most cases.

Since the bean is a leguminous plant it is not necessary to add any fertilizer containing nitrogen, but unless the land has been previously planted with velvet bean the following procedure should be carried out, where possible, in order that a good crop may be

obtained the first year: Secure a quantity of soil, equal to the amount of seed to be planted, from a field which has recently produced a crop of velvet bean, and just previous to planting moisten the seed and mix it with this soil. In this way the field is supplied with the micro-organisms which are necessary for the normal development of the velvet bean.

Its Uses.—The first and most important use to which the velvet bean may be applied is perhaps that of soil renovation. In Florida much of the land is abundantly supplied with humus or organic matter, and nitrogen, though it is equally true that the greater portion of the Florida soils is very deficient in these important substances. The velvet bean can accomplish for these poor soils of Florida what the cow-pea can do for all the southern states. For us, however, the velvet bean has greater advantages and is to be preferred. Under the head of culture it has already been indicated that the plant is an excellent one from which forage may be obtained. It may be used as green pasturage, harvested and converted into hay, or cattle and hogs may be turned in after maturity and the crop thus converted into meat at low cost. It has been used by some as a cover crop and as such proved satisfactory. The pods after grinding furnish a food rich in protein that is relished by poultry, cattle and hogs. This food is now on the market in some parts of the state. For many years it has been used as an ornament and as such is still in high favour.—(Florida Agr. Exp. Sta. Bul. 60.)

THE COWPEA.*

The nativity of several economic plants that have been in cultivation for a very long period is extremely difficult of determination. This difficulty is especially great in the case of the cowpea (*Vigna unguiculata*), because of its similarity to some other leguminous plants likewise in cultivation for several centuries, and the vague way in which these plants were described or alluded to by early authors.

Cowpeas for Hay.—Good cowpea hay is fully as valuable a food, pound for pound, as red clover hay, and very nearly equal in value to alfalfa or to wheat bran. The principal value of this hay lies in its high percentage of digestible protein, which is nearly four times that of timothy hay. One reason why cowpeas are not more extensively used as a hay crop is the difficulty often experienced in curing the large growth of succulent vines. Where proper care is taken in curing, especially where sorghum or a similar plant is grown with it in mixture, it is not a difficult matter to make good cowpea hay unless the weather is decidedly unfavorable.

When grown for hay production cowpeas are nearly always broadcasted or put in with a grain drill any time from May 15 to July 15. The quantity of seed used to the acre ranges from one to two bushels, broadcasting requiring from one-fourth to one-third more than is necessary when using a grain drill. The quantity most commonly used and which gives the most general satisfaction when the seed is put in with a grain drill is five pecks to the acre. The use of a grain drill is decidedly superior to broadcasting.

* For illustration, see page 393.

Larger hay yields have frequently been secured by planting in rows 24 to 36 inches apart and giving two or three cultivations, the seed required in this way being from two to three pecks per acre. The increased yield of hay due to cultivation is not sufficient to cover the increased cost, especially as rather thick broadcast seeding is equally as effective in destroying weeds as cultivation in rows. The practice of broadcasting on small grain stubble and plowing under the seed is still common; also that of putting in the seed on grain stubble with a disk drill without plowing. Both of these practices are rapidly being replaced by good preparation of the soil before seeding.

As nearly as average conditions will permit cowpeas for hay should be planted so that they will be at the proper stage for hay making in the latter part of August, in September, or early in October, as the rainfall is likely to be small during that time. With four to six days of dry, sunny weather, cowpeas can be cured into hay of excellent quality if they are at the proper stage of maturity when cut.

The proper time to cut cowpeas for hay is when most of the pods are full grown and a considerable number of them are ripe. At this stage none of the best hay varieties have dropped their leaves. Of the large list of cowpea varieties, those with an upright habit of growth which seed fairly well and mature quite uniformly should be chosen for hay. The varieties more commonly used are Whippoorwill, Unknown, New Era, and Iron. These hold their leaves well and stand up much better than most of the other varieties. Such varieties as Black, Red Ripper, and Clay are not desirable for the production of hay, as they run to vine badly and are consequently very hard to cure and handle. The readiness with which the hay can be cured depends largely upon the maturity of the vine and the condition of the weather; hence the advisability of having the harvesting come when the season is most likely to be dry.

An ordinary mower is the most practical machine for cutting cowpeas for hay, and if an erect variety is grown the entire plant can readily be saved. The mowing should begin in the morning, as soon as the dew is off, and may be continued all day if desired, though some advocate cutting only till noon. The vines should be left in the swath until well wilted on top, but not till the leaves are dry and brittle. They should then be raked into windrows; this may be the same day or the day after mowing. They should be left in the windrows one or two days and then put into small cocks of one or two forkfuls. The cocks should be left till the vines are well cured, from two to five or six days, depending on the conditions which have prevailed during the curing period. A good rule to follow is that peas are ready for stacking or putting into the barn when it is not possible to wring moisture out of the stems by twisting a handful with considerable force.

Cowpeas in Mixtures.—While cowpeas can be satisfactorily grown alone for hay, it is a much better practice as a rule to grow them in mixtures. The most widely used crop for this purpose is

sorghum. This includes both the sweet sorghums and the kafirs. The sorghum serves to support the cowpea vines, and its use usually results in increasing the yield of hay considerably. An additional important advantage is that the hay is more easily cured, as the sorghum prevents the matting together of the cowpea plants. Corn is also used very extensively in mixture with cowpeas, but only to a small extent for hay purposes. The two are grown together very satisfactorily in cultivated rows. Other crops that have been used to grow in mixture with cowpeas are millet, soy beans, and Johnson grass.

Cowpeas and Sorghum.—In the Piedmont region of the South a large percentage of the cowpeas planted for hay is in mixture with sorghum, and the practice should spread rapidly, as this mixed hay is very nearly a complete ration and is relished by all farm stock. The mixture has given excellent satisfaction on the Arlington Experimental Farm, near Washington, D. C. The variety of sweet sorghum most used is the Amber, as it is not as coarse as the others and hence cures more rapidly. The seeding is best done with a grain drill on well-prepared land, the two kinds of seed being well mixed and sown at the same time. The best rate is one bushel of good seed of cowpeas to one-half bushel of sorghum to the acre. If a grain drill is not available for seeding, the cowpea seed should be disked or plowed in and the sorghum seed should then be sown while the land is rough, and covered with a drag harrow. The Whippoorwill, Iron, Unknown, and Clay cowpeas require about the same time as sorghum to mature and therefore should be used instead of the early varieties. In general, the planting may be done from June 1 to July 15.

Growing cowpeas and sorghum together in cultivated rows gives excellent results. They should be planted together in rows 2½ to 3½ feet apart, three pecks of cowpea seed and about one-third of a bushel of sorghum seed being used to the acre. The Sumac and the Orange varieties are fully as good as the Amber sorghum for this use, as they grow larger and stronger plants.

Cowpeas and Corn.—Cowpeas are most widely used at present for growing with corn. When grown in this way a farmer secures a crop of corn, sufficient cowpea seed for use the next season, and either a hay crop or a certain amount of grazing for his stock. The cowpea is an excellent plant to grow with corn for ensilage, and is being used quite extensively for this purpose on many dairy farms, especially in the northern part of the cowpea region. When planted in the cornfield it is usually at the last cultivation of that crop. The quantity of seed used to the acre ranges from a half bushel or less to two bushels, depending largely on whether the planting is broadcast or in rows close to the corn. Generally the best results are obtained by the use of about three pecks of seed and planting near the rows of corn, preferably with a corn, cotton, or other planter, immediately after the last cultivation of the corn. Usually the peas are allowed to ripen a fair percentage of pods, which are gathered for next year's seed, and the vines are then pastured.

In the sugar-cane districts of Louisiana and in parts of Mississippi and Alabama the cowpeas are made into hay instead of being pastured after the corn has been gathered. This is a very good practice and is becoming general. The work is very satisfactorily done with a strong wooden-toothed rake, which pulls the vines and leaves them in small bunches for curing. The harvesting is also done with a mower to some extent.

In a few localities, especially in parts of Maryland, corn and cowpeas are sown thickly together for hay with excellent results. The seeding for this purpose is at the rate of one-half to one bushel of corn and one bushel of cowpeas to the acre. The two mature at practically the same time, the yield is large, and the curing is easily done.

Cowpeas and Johnson Grass.—Where Johnson grass is not a pest or where it is well established on a field and there is no desire to clean it out, it can very satisfactorily form a part of a mixture with cowpeas. At the Arlington Experimental Farm in 1906 the mixtures of Johnson grass and cowpeas gave the best results both in yield and in the quality of the hay produced. There is no difficulty in killing out Johnson grass north of Tennessee and central Virginia, but south of these States the difficulty increases rapidly.

The mixture should be sown at the rate of one bushel of Johnson grass and one bushel of cowpeas to the acre; if the seeding is done with a grain drill, care must be exercised not to cover the Johnson grass seed too deeply. Where this grass is already established, the land may either be plowed or thoroughly disked in late spring, the treatment depending on the nature of the soil, and then the cowpeas alone should be sown in June. One and a half bushels of cowpea seed to the acre are frequently used, as the Johnson grass makes a more vigorous growth under such circumstances than when coming from seed. This latter practice is common at Augusta, Ga., and gives excellent results. The quality of hay obtained is very good and it is not as coarse as the mixture with sorghum. The fact that Johnson grass often becomes a troublesome weed is the only objection to it in mixture with cowpeas for hay production. In other respects it is the best plant for this purpose.

Cowpeas and Millet.—German millet has often been grown in mixture with cowpeas. As it matures in a relatively short time it is adapted for growing only with the early varieties of cowpeas, such as the New Era, and even with these the yield is rarely increased. The millet aids materially in curing the hay, however, and possibly improves its quality by adding variety. Millet should never be used in mixture with the late and rank-growing cowpeas, as the results obtained are not satisfactory, since in addition to maturing too early the millet is not strong enough to hold up the cowpea vines.

Cowpeas and Soy Beans.—But little experimenting has been done in growing soy beans and cowpeas together, but the results obtained have been very promising.—(See soy beans.)

Cowpeas for Pasture.—The use of cowpeas for pasture is not as a

rule the best farm practice, but under certain circumstances it is advisable and fairly profitable. Grazing cultivated lands is likely to render succeeding tillage more difficult on account of the trampling by stock; and, unless care is exercised in pasturing cowpeas, loss of animals by bloating may result, especially in wet weather. Cowpeas when planted in corn are very commonly used for grazing, especially with hogs.

The Oklahoma Agricultural Experimental Station reports that cowpeas planted early in July furnished two grazing periods for milk cows before frost in the fall and that the flow of milk was noticeably increased. At the Arkansas Station steers were fattened on cowpea pasture and cotton seed, making an average gain of 2 pounds a day for ninety days. So long as the pea vines were green and considerable seed was available, very little cotton seed was eaten. The cost of each pound of gain was only 2 cents for the cotton seed, thus showing the high value of the cowpea pasture.

Feeding Value of Cowpeas.—The feeding value of cowpea hay has long been recognized, as it has been used extensively for all kinds of stock in the Southern States. With a fair number of ripe peas in the hay it has been found to be satisfactory when fed alone to stock at work, and can be used very successfully as a maintenance ration for horses, mules, cattle, sheep, and even hogs. The farmers in the sugar-cane districts of Louisiana make a very extensive use of cowpea hay for their work stock, it being practically the only roughage used. It is generally claimed that horses or mules at work stand hot weather better when fed cowpea hay than when fed a grass hay and corn. The difference in the appearance of the animals is also very much in favor of the cowpeas.

In a three months' test at the North Carolina Agricultural Experiment Station the rations fed two high-grade Percheron mares, used as a team and receiving the same care and shelter, differed only in the use of 10 pounds of cowpea hay in one and the same quantity of wheat bran in the other. The horse fed bran just held its own in weight while the one fed cowpea hay gained a little. The cowpea ration was 5 cents cheaper in daily cost.

At the Arkansas Agricultural Experiment Station two three-year-old steers were fattened on cowpea hay and cotton seed in a feeding trial lasting ninety days. The daily ration consisted of 13 3-5 pounds of cotton seed and 20 pounds of pea hay. The average daily gain was 3 pounds for each steer, and the cattle were in excellent condition during the entire trial. The profit realized was $21.30. The Tennessee Agricultural Experiment Station found that 6 to 10 pounds of cowpea hay could be substituted for 3 to 5 pounds of cotton-seed meal in beef production. This indicates that this hay can be utilized to advantage in place of corn and cotton-seed meal when these feeds are high priced.

In the production of milk and butter, the Tennessee Agricultural Experiment Station reports that 1¼ pounds of chopped pea hay is equivalent to a pound of wheat bran, and 3 pounds of chopped pea hay to a pound of cotton-seed meal. With bran valued

at $20 a ton a yield of 2½ tons of cowpea hay would mean a return of $40 an acre for the crop, based on its feeding value. Cowpea hay is equally as good as bran for producing a flow of milk.

Cowpea Seed.—The seed of cowpeas is rarely obtainable at a low enough price to be used as a feed. Its composition indicates that it is a richer feed than wheat bran. The Alabama Agricultural Experiment Station fed cowpeas to fattening pigs with excellent results. More lean meat was found in the bodies of the pigs fed cowpeas than in those fed corn meal only. A great many people have tried feeding the seed, either whole or in broken pieces, to poultry. Splendid results are obtained, the fowls being kept in good condition and producing a good supply of eggs, even in the winter months. Very good results are also obtained by feeding the hay, as the fowls eat all except the hard, coarse stems.

Cowpea Straw.—Now that cowpea seed can be secured by running the vines through a thrashing machine the straw is coming to be quite an important feed. While no authentic data are at hand in regard to this straw, farmers and stable keepers who have used it claim that it is an excellent feed, some even preferring it to ordinary pea-vine hay. There have been no ill effects reported from its use. The straw sells for about the same price as the hay.

Growing Cowpeas for Seed.—The greater agricultural use of cowpeas has been seriously handicapped in late years by the high price of seed. Until the last few years cowpea seed has been almost entirely gathered by hand, though that harvested by machinery makes up an increasing percentage of the commercial seed each year. Cheaper seed will undoubtedly bring about an enormous increase in the culture of the crop.

Cowpeas when grown for seed or for combined seed and hay production are nearly always sown broadcast or with a grain drill. Occasionally fields are planted in rows and cultivated. Experiments generally prove that the largest yields are secured by planting in rows and cultivating, but in many localities this increased yield is not sufficient to offset the additional cost of cultivation.

The planting of cowpeas for seed production should always be thinner than for forage purposes. When the seed is broadcasted the quantity ranges from 3 to 6 pecks to the acre, depending on the soil, the method of seeding, and the size of seed. Heavy clay or light sandy soils require more seed than loam soils. If sown with a grain drill only about two-thirds as much as for broadcasting is required. Of the smaller seeded varieties, such as the New Era and the Iron, 2 or 3 pecks will give the best results; while of the larger seeded varieties, such as the Black, the Unknown, and the Whippoorwill, the quantities range from 3 pecks to 5 pecks to the acre a bushel generally being the best amount to use. In most of the cowpea region planting for seed production should be rather late in the season, since late plantings as a rule give much better seed yields than early plantings. This is not the case, however, in Oklahoma and northern Texas, where early seeding gives the best yields, owing

probably to the lighter rainfall. In certain sections near the Gulf, two seed crops in a season may be secured by growing in rows and planting the first very early.

Hand Picking.—The method of gathering seed by hand is the only one practicable where the peas are planted in corn, which is a very common practice throughout the South. The cowpea seeds are planted at the last cultivation of the corn and are nearly always ripe before frost. The vines climb the corn stalks, so most of the pods are well above ground, which greatly facilitates gathering them. They are picked by hand into bags, and later flailed or run through a pod huller. The cost of hand picking ranges from 40 to 75 cents a hundred pounds of pods, or the picker is given one-third to one-half of the total quantity gathered. This method of harvesting naturally makes the price of seed high. Fields grown to cowpeas alone for seed production are often hand picked. The yield of seed in such cases is as a rule much larger, and a larger number of pods can be picked in a day than when grown with corn. The Blackeye and similar varieties grown for table use are usually picked by hand.

Machine Picking.—The scarcity of seed and the difficulty of securing labor have resulted in the invention of several so-called pea pickers. These machines are intended to gather the pods from the vines in the field. The peas must be planted in rows for the most successful operation of a pea picker, and the entire plant must be ripe and dry before the machine will do satisfactory work. Two of these pickers are constructed on much the same principle, that of a winged drum revolving rapidly over a stationary moderately sharp edge. The pods are thus knocked back upon a platform and then elevated into a receiving box or bag. A third machine differs from the foregoing in that the picking apparatus is very much in the nature of a flailing operation, the cylinder consisting of four arms made up of pieces of gas pipe. This revolves rapidly and knocks the pods back into the gathering box. A fourth machine is a harvester and thrasher combined. In this, the vines are cut with an ordinary mowing arrangement and passed directly to the thrashing part of the machine, which is essentially the same as that of any thrasher. This last-mentioned machine is very satisfactory for harvesting perfectly ripe peas, since it very nearly completes the operation. For harvesting varieties grown for table use, such as the Blackeye, the Lady, and other white peas, it may find considerable demand.

Cowpeas for seed production are quite satisfactorily harvested with a mower. A bunching attachment has been used with excellent results. This gets the vines out of the way of the team, thus avoiding considerable loss of peas through trampling and crushing by the mower wheels. It also leaves the vines in a more desirable shape for curing, they being rolled into small windrows. The self-rake reaper is a very satisfactory machine for mowing cowpeas for seed, accomplishing even better results than the buncher on a mower,

as the vines are left in bunches of very convenient size for curing and handling.

Cowpeas for Soil Improvement.—The beneficial results of growing cowpeas are due largely to the ability of the plants, like those of alfalfa and red clover, to take nitrogen from the air by means of the bacteria which live in the nodules on the roots. Cowpeas also improve markedly the physical condition of the soil. This, taken in connection with their ability to produce a crop quickly on even the poorer soils, makes the cowpea particularly valuable both as a catch crop and in regular rotations when utilized either for hay or seed production.

At the present time the most popular rotation for the entire South is one which allows the largest possible area to be planted in cotton each year. A system of cropping which is in general use is three years in cotton, the fourth year in corn and cowpeas, and then three years in cotton again. This system allows three-fourths of the farm to be in cotton each year, and is applicable to all of the better agricultural land. On the poorer soils of the cotton belt it is likely that better results would be secured by growing cotton only two years and corn and cowpeas the third year. This would leave two-thirds of the farm for cotton each year, and would undoubtedly be an excellent system of cropping. The Alabama Agricultural Experiment Station reports an increase in yield in one case of 696 pounds of seed cotton to the acre, or 83 per cent, due to plowing under a crop of cowpea vines on land which had been in cotton the previous season. The Arkansas Agricultural Experiment Station secured an increase in yield of 59 per cent where a crop of cowpeas had been grazed the preceding year.

Practically the same plan of rotation is followed in the sugar-cane districts of Louisiana. Three crops of cane are taken off the land, and the fourth year it is planted to cowpeas or to corn and cowpeas. The work stock are fed almost exclusively on pea-vine hay or are grazed on cowpeas in the cornfield after the corn has been gathered. This rotation gives excellent results in the succeeding crops of cane.

A rotation of wheat or oats and cowpeas is giving excellent results in parts of Missouri, Arkansas, and Tennessee. Cowpeas are sown on the land immediately after the removal of the grain crop and are utilized for hay or seed or for pasture. Grain is sown again in the fall, thus making two crops a year from the same land. In many instances landowners in Arkansas and Missouri have allowed tenants the use of land free of charge for producing a crop of cowpeas, stipulating, however, that the land must be well prepared. When the soil is given good preparation before sowing the cowpeas, it is not necessary to plow in the autumn for the grain. The fall preparation usually consists of disking the cowpea stubble and sowing the grain with a drill. Occasionally the seeding is done with a disk drill without any preliminary preparation. The increase in yield of wheat due to the cowpeas is generally given as from 3 to 5 bushels per acre. At the Missouri Agricultural Experi-

ment Station, an increase in yield of 63 per cent with oats and 49 per cent with wheat following cowpeas as a catch crop was secured. The Arkansas Agricultural Experiment Station reports as the average of a four years' test on wheat an increase of 25 per cent from plowing under cowpea stubble the first fall, 39 per cent from plowing under cowpea vines, and 42 per cent where cowpeas were grown each year as a catch crop between the wheat crops, only the stubble of the peas being plowed under. The increased yield in the latter case amounted to 70 per cent in the fourth season, the yields having gradually increased from year to year, in addition to producing a fair quantity of very nutritious hay each season.

On farms where more or less live stock is produced the following three-year rotation is very popular and is a good one: First year, cotton; second year, corn with cowpeas at last cultivation; third year, winter oats or wheat, with a catch crop of cowpeas for hay or seed after the grain has been removed.

VARIETIES OF COWPEAS.

There are at present about 50 varieties of cowpeas generally known, but only a few of the best of these are extensively cultivated. The varieties differ in such characters as habit, size, earliness, prolificness, disease resistance, and especially in the color of the seeds, which are either entirely white, red, buff, black, or blue, or variously blotched or speckled. The varieties are all very constant in their seed characters. The variation in vines, however, is very marked, being influenced by the time of planting, the nature of the season, and the locality where grown. Early planting or a wet season usually results in a large growth of vines. Natural crosses between the varieties occur under favoring conditions, but they are far from common. The use to be made of the crop by the grower should determine largely which variety to select.

For table use the varieties with white or nearly white seeds are preferred, as they make a more attractive dish. The habit of growth of the table peas is of little direct concern, and, as a matter of fact, none of them is very satisfactory for forage purposes. The principal varieties are the Blackeye, of which there are several strains, the Browneye, the Lady, and the Cream. These are more properly considered vegetables. Several of the colored-seeded varieties are also used as table peas.

For forage purposes the most desirable varieties are those which have a fairly upright habit, grow to large size, hold their leaves well, and produce an abundance of pods. Descriptions of the most important varieties follow. Of the numerous remaining varieties none is grown to a very large extent, and most of them are distinctly inferior to those described here.

Whippoorwill.—This is known under several other names, such as Running Speckled, Bunch Speckled, and Shinney. It may be considered the standard of all field cowpeas. It is suitable either for grain or hay production, or both. It makes a vigorous growth, is fairly erect, and still produces a large amount of vine. It can readily be handled by machinery, which is bringing it more and

HAY COCKS PROTECTED. DEPT. OF AGR.

more into prominence. The seed is mottled chocolate on a buff or reddish ground color.

Unknown, or Wonderful.—This is another field variety which is grown to a large extent. It is the largest growing and most vigorous of the cowpea varieties, but is late in maturing, it being difficult sometimes to secure seed of it as far north as Washington, D. C. The principal objection to this pea is its light seeding. It is nearly as erect as the Whippoorwill variety; hence, it is quite readily handled by machinery either for grain or hay production. The seed is large in size and of a very light clay color.

New Era.—This is the smallest seeded of the cowpeas that have found a wide use. The seed is bluish in color, owing to the innumerable minute blue specks on a gray ground. The New Era is the most nearly erect of any of the varieties, rarely having any prostrate branches. It usually produces a heavy crop of seed and matures in from seventy-five to ninety days. It is one of the earliest of the cowpea varieties and is the most easily handled by machinery. The small seed is not usually considered an undesirable character, as a smaller quantity is required for seeding than is the case with other varieties.

Groit.—The variety known by this name has been much confused with the New Era cowpea. In habit the two are much alike, but the Groit is a little superior, as it makes a larger growth and fruits more heavily. The seed is quite similar to that of the New Era, but has chocolate mottlings in addition to the blue specks. It is quite certainly a hybrid between the New Era and the Whippoorwill varieties.

Iron.—The Iron variety is coming rapidly into prominence. In its habit it is only slightly different from the Unknown, though it is not quite as vigorous or as large. It is earlier than the Unknown, and the seed, though nearly the same color, is much smaller, being but very little larger than that of the New Era. The characteristic of the Iron cowpea which has been instrumental in bringing it into prominence is its resistance to wilt and to root-knot caused by eel worms. It is the only one of the cowpeas which has been found to resist these diseases. Where they are prevalent in the soil, the Iron cowpea is the only variety which can be successfully grown, and since the diseases are spreading the distribution of the Iron cowpea is also increasing. This seed is hard and retains its vitality better than that of most varieties. It will lie in the ground through the winter and germinate the next spring. This variety and the Unknown hold their leaves better than any others.

Clay.—This is more variable in its habit than any of the foregoing varieties. It is the most pronounced trailer of any of the peas grown quite largely, and is consequently in very slight favor where the pea crop is handled by machinery. The plants are very vigorous but low growing, and they usually seed sparingly. Since seed is such an important item at the present time, a variety which has but poor fruiting qualities is not apt to remain popular, even though it may be harvested readily by machinery. The seed is of

the same color as that of the Unknown and the Iron, but is intermediate in size and flatter and longer.

Black.—This is used to a considerable extent in the sandy coastal plain soils of Virginia and North Carolina. On heavy clay land this variety makes a very heavy growth of vine, but produces very little seed, while on the sandy lands it grows more bushy and fruits quite heavily. It also finds some demand in the sugar-cane section of Louisiana, where it is grown with corn in rotation with sugar-cane. Where other varieties thrive the Black is not a favorite. The seeds are quite large and entirely black.

Taylor.—This variety has larger seeds than any other cowpea. The seeds have nearly the same marking as those of the New Era, though the ground color is somewhat lighter. The Taylor cowpea has met with considerable favor in Maryland and Delaware, where it is erroneously called the Gray Crowder, but outside of this region does not seem to be a very valuable variety. In most cases it is too much of a trailer to be desirable. It also has a tendency to drop its leaves earlier than any of the other varieties except the Black.

Red Ripper.—This is a valuable pea, as it makes nearly as large a growth as the Unknown, or Wonderful, and is excellent for growing in corn. It is very late, usually maturing but a small number of peas at Washington, D. C. It is difficult to procure seed of it in quantity on account of its light yield. The seed is dark red and about the same size as that of the Whippoorwill variety.

Results of Tests of Varieties of Cowpeas.—The number of tests of varieties of cowpeas conducted throughout the state in 1907 was 71. Of these 57 consisted of the regular sets of four varieties each. The chief object of these tests was to determine the relative yields of total dry matter for forage or hay. The production of seed was not considered so important. The results were all satisfactory to a high degree. In nearly all cases profitable yields of forage were secured, while the yields of seed varied considerably. In order of maturity the varieties range as follows: Early Blackeye, Michigan Favorite, Whippoorwill, New Era, Iron, and Clay. All may, however, be cut for hay about September 1. The quality of hay produced is generally excellent and its nutritive value is about one-half greater than that of clover hay.—(Ind. B. 124.)

The cowpea is an annual plant, but under favorable Hawaiian conditions may produce one or even two rattoon crops. In appearance the plant resembles the bean more than the pea, and like the bean it appears to be more sensitive to wet and cold. The commonly grown varieties are characterized by their vigorous growth and rambling or trailing habit. Compared with other viney legumes of like vigor, the cowpea would be classed as early maturing. When planted in rows and well cultivated the vines may attain a length of ten or more feet and produce a great amount of foliage. Where the seed is thickly broadcasted, they show less inclination to throw out strong tendrils and produce less seed and foliage. Most of the standard varieties are heavy seeding, but for the maximum produc-

tion of seed, especially if uniform maturity is desired, the crop should be planted thinly, preferably in rows, and at such a time as to ripen the seed during the warmer and drier seasons of the year. In comparison with the growth above ground the root system of the cowpea does not appear to be as extensive as in most other legumes, nevertheless the plant is quite drought resistant, due to its shading the ground so thoroughly. The roots are nearly always supplied with the nodules which harbor the nitrifying bacteria so important to enriching both the plant and the soil.—(Hawaii B. 23.)

SUMMARY.

(1) The cowpea is the best legume for the entire cotton belt, and can be profitably grown much farther north. It is especially suitable for combined hay and seed production or for hay alone.

(2) To make good cowpea hay requires careful handling of the crop. The plant should have made its growth and have at least the first pods ripe when the mowing is done. Uniformity in maturing is essential in getting the best results. The use of a tedder is very helpful. The serious loss of leaves can be avoided by not handling the hay when the leaves are dry and brittle. The curing is best done in small cocks, and the hay is ready for the stack or barn when no moisture can be wrung from the stem by twisting it with considerable force.

(3) Cowpeas for hay production are very advantageously grown in mixture with sorghum, Johnson grass, or soy beans. The yield is thus increased, the quality improved, and the curing more easily done. Cowpeas give very good results when grown with sorghum in cultivated rows and are very commonly planted in corn and used for grazing or ensilage.

(4) Pasturing cowpeas is not the most economical practice, but it is frequently resorted to because of the small expense it entails. Cowpeas are especially suitable for grazing hogs.

(5) Cowpea hay is very nutritious. It is nearly equal to wheat bran as part of a ration. It is satisfactory for work stock and for beef or milk production, and it gives good results when fed to poultry. The grain is a rich feed, excellent for poultry but little used for other feeding. Cowpea straw is an excellent roughage and nearly as valuable as the hay.

(6) Cheaper cowpea seed will result in the much more extensive growing of the crop. Harvesting for seed can be done most cheaply by the use of machinery. The crop should be cut with a mower or self-rake reaper when half or more of the pods are ripe. When thoroughly dry the thrashing may be done with an ordinary grain separator with some modifications, with a two-cylinder cowpea thrasher, or with a one-cylinder special machine which has all the thrashing spikes sharpened in addition to having ingenious devices which make it the most satisfactory thrasher for handling cowpeas.

(7) Cowpeas add nitrogen to the soil and improve its mechanical condition. It is most profitably grown in rotation with other crops. The following rotations are good ones: (*a*) Cotton, three

years; corn and cowpeas fourth year; and then cotton again. This is all right on the better soils of the South, but the cotton should be planted only two years in succession on the poorer soils. (*b*) Wheat or oats with cowpeas each season after the removal of the grain crop, the land being seeded to grain again in the fall, making two crops a year from the same land. (*c*) Cotton, first year; corn and cowpeas, second year; winter oats or wheat followed by cowpeas as a catch crop, third year; and then cotton again.

(8) The most valuable varieties are the Whippoorwill, the Unknown or Wonderful, the New Era, and the Iron for field purposes; and the Blackeye for table use.

(9) The Iron cowpea is practically immune to the two serious diseases, wilt and root-knot, which attack the other varieties more or less. It alone should therefore be grown wherever these diseases are prevalent.—(Farmers' Bul. 318, 1908; B. P. I., B. 102; Ill. Circular No. 5; Del B. XLVI; La. B. 40; Tex. B. (no date); Va. B. 149; Ala. B. 118; Okl. B. 74; Mo. B. 73; Del. B. 55; Mich. B. 199, and several of those cited in connection with forage plants.)

MILLETS.*

The Cultivated Varieties.—With one or two exceptions the millets grown in the United States belong to the genera *Chætochloa* and *Panicum,* and may be arranged into three groups—(1) Foxtail, (2) Barnyard, and (3) Broom-corn. In the first group are those belonging to the genus *Chætochloa* (formerly *Setaria*), with a compact, bristly, foxtail-like head, closely related botanically to the common foxtail grasses of the fields and waste places; this group, which may be termed the foxtail millets, includes such varieties as Common Millet, Hungarian, and others. A second group is composed of varieties derived from the common barnyard grass, distinguished by the dense paniculate heads so characteristic of barnyard grass; although extensively cultivated in parts of the Old World, the millets of this group, which may be designated the barnyard millets, have only recently come into prominence in American agriculture. The third group comprises millets with bushy heads, the seeds being produced at the ends of the comparatively long branches; this group includes the common millet of the Old World and the varieties derived from the same species, regarded by many as the true millets.

Foxtail Millets.—The foxtail millets delight in rich, warm, loamy soils, and will not thrive in soils that are poor and thin. This is particularly the case with the coarser varieties like German Millet. Common Millet and Hungarian usually give better results under adverse conditions of soil and climate than the other varieties commonly grown in this country. The foxtail millets are strong, rapid growers, and draw nourishment largely from the surface soil. The great mass of strong, fibrous roots have a beneficial effect on the physical condition of the soil, particularly in the case of lands recently brought under the plow. A crop of millet on new breaking aids materially in subduing the land and in preparing it for the succeeding crop. In many localities, notably in the West, millet is an excellent crop to precede corn. In the South the foxtail millets are

*See page 593, for illustration.

regarded as well adapted to the upland soils of the cotton regions, Common Millet being best for the light soils and German Millet for low, heavy soils.

The foxtail millets not only endure excessive heat and sunlight well, but make very rapid growth if the supply of moisture is not too limited. They are, however, very susceptible to cold, particularly when the plants are young. The length of time required to reach maturity varies a great deal, according to the variety and the soil and the climatic conditions, the commonly grown varieties ordinarily being ready to cut for hay in from fifty to eighty days from date of sowing and maturing seed in from ten to fifteen or twenty days later. Under very favorable circumstances some of the varieties may be in condition to cut for forage within a month or six weeks from time of seeding.

Varieties.—The various foxtail millets commonly found on the market in the United States may be grouped under the following standard varieties: (1) Common Millet (*Chætochloa italica*); (2) German Millet (*Chætochloa italica*); (3) Golden Wonder Millet (*Chætochloa italica*); (4) Hungarian Millet (*Chætochloa italica* var. *germanica*).

Common Millet.—Synonyms: Small Millet (Texas), Californian Millet (Salzer, Vilmorin), Dakota Millet (in part, of some seedsmen), Early Harvest Millet or Missouri Millet (at least in part), American Millet (in part). Common Millet was one of the first varieties to be introduced and to come into general cultivation in the United States, but there seems to be no record of the exact date of its introduction. At the present time it is the most widely cultivated of the foxtail millets in this country. It is the hardiest of the commonly grown varieties, enduring drought the best and giving better returns on poor soils. By most feeders the hay from this variety is preferred to that from others on account of its finer quality, there being less loss in feeding it. Although German Millet will usually outyield Common Millet under favorable conditions of soil and moisture, the latter will, one year with another, afford more forage of a finer quality in most localities in the Northern States. Common Millet is one of the earliest of the foxtail millets, and is the most constant in its character. German Millet makes a heavy yield of forage under favorable conditions, but does not stand drought as well as the smaller varieties, such as Common Millet and Hungarian. The hay is coarser and less highly valued than that from the smaller millets, but when the forage can be fed in the green state this will be found to be an excellent variety to grow, on account of the heavy yield. German Millet is the latest of the varieties commonly grown here, and is exceedingly variable in its appearance and habit of growth. It is very seldom that one sees a field that is uniform in character. Many, perhaps most, of the heads may be typical of the variety, but usually there will be many others scarcely to be distinguished from Common Millet or other standard varieties. Typical German Millet brought from the South soon becomes very much modified when grown in the North. Thus, in a northern strain of

German Millet sold as Dakota Millet or Dakota-grown German Millet, the seed is larger and more oval in shape than in the typical southern form; the plants are earlier and hardier, and the yield of forage is usually better, at least in northern localities. Some of the so-called Japanese millets now on the market belong to the German Millet type, as, for example, Breck's Japanese Millet, which is scarcely distinguishable from the common southern German Millet.

Golden Wonder Millet.—Synonyms: Sometimes confused with the so-called Golden (German) Millet. In yield of seed Golden Wonder leads all the other varieties of fox-tail millets. The forage is coarse, like that from German Millet, and the yield heavy under favorable conditions, but Golden Wonder is even more susceptible to drought than German Millet, and is therefore less generally grown than any other of the well-established varieties. At the present time it is most extensively cultivated in the States along the Upper Mississippi and Lower Missouri valleys. Much of the seed sold under this title is untrue to name. German Millet is perhaps oftener sold as Golden Wonder than any other variety.

Hungarian Millet.—Synonyms: Hungarian Honey, Hungarian Grass, German Millet (in the Old World and in small part in this country). Hungarian does not resist drought as well as Common Millet, but with favorable conditions of soil and moisture it will usually give a somewhat heavier yield. One reason why Hungarian has not found more favor with farmers generally is that it shows a greater tendency than other common varieties to persist in the soil when allowed to mature seed before harvesting. In portions of the Missouri Valley region, as in eastern Nebraska and Iowa, this millet received a great deal of attention from farmers during the seventies, and fine crops of hay and seed were obtained, but its tendency to volunteer brought it into more or less disfavor, and it is now less commonly grown than either Common Millet or German Millet. It seldom becomes troublesome, however, except on light, sandy soils or land recently brought into cultivation. On moist, heavy soils or in regions where there is a great deal of wet weather during the fall and winter months it is not likely to make much volunteered growth.

Japanese Foxtail Millets.—Under the name of Japanese Millet several different kinds of foxtail millets are being grown in various parts of the country. Some of these are apparently identical with varieties already grown in this country, and others are so closely allied that further study is necessary before they can be given a place either as distinct varieties or as forms of better known sorts. As illustrating this point, such cases may be cited as Breck's Japanese Millet, mentioned under the discussion of German Millet, and Gregory's Japanese Millet, noted under the head of Golden Wonder Millet. Several sorts imported from Japan by Professor Brooks seem more distinct as cultivated varieties, and will no doubt soon be given appropriate trade names.

As a rule these Japanese millets are comparatively large forms, giving heavy yields of seed or forage under favorable conditions, but

with little ability to withstand drought, succumbing quicker than any of the commonly grown sorts. Some of them, however, have given good results in certain localities, and it is not unlikely that they may ultimately prove to be desirable for general cultivation, or valuable sorts may be developed from them by selection and crossing.

True Barnyard Millets.—These are undoubtedly the most valuable varieties of this group for cultivation in this country. The varieties that give best results under cultivation are those with upright habit of growth, a close head, and a tendency to produce a large quantity of leaves. Of the varieties at present grown in the United States, one of the recently imported Japanese sorts is probably the most promising. It is a coarse-growing form with a heavy leafage and compact beardless heads. This variety has been thoroughly tested at the Massachusetts Experiment Station, and is highly recommended as a forage crop. It matures a crop of hay in about two and one-half months. There are several valuable varieties in various parts of our own country, the most notable being those found in prairie regions of the West and Northwest and the "Ankee" grass of the Southwest. In the artesian-well region of the Dakotas there are wild forms of barnyard grass that seem particularly well adapted to the conditions that prevail in the vicinity of the flowing wells, especially where the soil has been watered too freely. In many places considerable areas about the ponds and along the ditches are covered each season with a growth from 3 to 6 feet high. Similar areas may be seen elsewhere in the West and Northwest in irrigated regions, and they are yearly becoming more common. In the southwestern part of the United States there is a large, thrifty form of this grass, which makes a very fine growth in lowlands and swampy places during the wet season. It is known to the Mohave Indians as "Ankee," and its seed is said to be extensively used by them as food.

In addition to the above-mentioned inland forms, there are coastal forms growing in brackish marshes and meadows along the seacoast, possessing much value for forage. One of these is quite different in appearance from all other forms of barnyard grass, and is probably specifically distinct. The lower leaf sheaths are very hairy and the heads are conspicuously bearded. The plants attain a height of from 3 to 6 feet. This grass may well be given a trial on saline soil in inland regions.

Barnyard Millet does not endure drought well, being more susceptible than the common sorts, and it can not be profitably grown on poor soils. On the rich prairies of the West and Northwest heavy yields may be obtained where the supply of moisture is sufficient, as when under irrigation. It seems to thrive better on the alkali soil so common in some parts of the West than either Common or German Millet. In some parts of the South, particularly in the lower Mississippi Valley, it makes a fine yield of hay, sometimes affording two cuttings a season, and, although an annual, it continues to occupy the land year after year through the great readiness with which it reseeds itself. In these localities it furnishes a large proportion of the volunteer hay crop and is also used for soiling.

Shama Millet or Jungle Rice (Panicum colonum).—This is a grass with much the appearance of Barnyard Millet, but is smaller in every way, with a simpler inflorescence or head. It is common in the tropical and subtropical regions of the Old World, where it is a native, and is widely introduced into the other warm regions of the globe. In the United States it occurs chiefly in waste places along roadsides and ditches, mostly in the South. It is quite abundant in parts of the Southwest and also in Mexico.

Broom-Corn Millets.—In the United States the term Broom-corn Millet is at the present time generally applied to this Old-World grass. It is the common millet of Europe, where it has been cultivated for centuries.

Culture of Millets.—For this crop a fertile, mellow soil is preferable. Loams with but little clay and not too much sand give the best results. Heavy clay soils require considerable working in order to get them into proper condition. For spring sowing the land may be plowed in the same manner and at about the same time, or perhaps a little later, as for a crop of corn.

Seeding.—When millet is handled as a primary crop, seeding is generally done during the latter part of May or early in June in the North, and, of course, correspondingly earlier in the South; or, if the moisture conditions are favorable, it may be delayed as late as August 1 in the latter region. It is a general rule to sow millet as soon as the corn in planted. The foxtail and broom-corn millets and some of the barnyard millets are quite sensitive to cold, and hence seeding should be postponed until the ground has become thoroughly warm and danger from protracted cold is past. It should, however, take place before the dry period of the summer begins. A succession of crops for soiling or silage can easily be obtained by sowing at periods of two or three weeks from May 10 to late in July.

Millet may be harvested for the seed in the same manner as small grain of any sort. One of the best ways is to cut with a self-binder, place the bundles two and two in long, narrow shocks, with the long diameter north and south, let stand until dry, and thrash from the shocks. This method is quite generally practiced where the millets are most extensively grown for seed. It is possible that seed of a better quality may be obtained by stacking the millet before thrashing; but whether or not the gain would be sufficient to pay for the expense of stacking is doubtful. The crop should not be allowed to become too ripe before cutting, for the seed falls out badly during the process of curing and thrashing. Probably the best time for harvesting for a crop of seed is when the seed is in a stiff dough.

Uses and Feeding Value.—Millet is fed principally as a hay and soiling crop. The forage ranks well with that of other grasses in the nutritive content, and its palatability is about that of the average for the coarser sorts. For digestibility, millet forage compares favorably with that from other coarse grasses. Already widely grown as a hay crop, millets deserve more general use for soiling. They are particularly valuable for feeding to dairy cattle, young stock, and

sheep. There are many sections of the country where this crop can be made to supplement the pastures in such a way as to allow a material increase in the number of stock that can be kept on the farm.

Composition and Digestibility.—The millets are all much alike in composition and digestibility, there being often more variation in the forage from a single variety cut at different periods in the development of the plant than between that from different varieties, particularly when cut at about the same stage of growth. This shows the importance of cutting at the proper time in order to obtain the richest, most palatable, and most digestible forage.

Manure Value of Millets.—While this crop is of little importance as a fertilizer, when compared with the clovers, cowpeas, and other leguminous crops, a knowledge of the kind and quantity of fertilizing substances contained in the millet plant will give an idea as to the drain on the elements of plant food in the soil by this crop. There are many sections of the country in which the soil is very poorly supplied with vegetable mold, and the turning under of any leafy growth will prove beneficial. If the better leguminous crops are not at hand or can not be grown, millet or any other plant that will grow on the soil and produce a heavy foliage may well be used for the purpose. The following table (adapted from Ninth An. Rep. Mass. (Hatch) Agr. Exp. Sta.) shows the amount, in pounds, of the various important fertilizing ingredients found in the millets, and also the comparative value of a ton of the hay, straw, seed, or fresh material at an average market price for these ingredients:

Variety	Nitrogen	Phosphoric acid	Potash	Value
	Pounds	*Pounds*	*Pounds*	*Dollars*
Japanese Foxtail Millet (fresh)	12.2	3.8	8.2	2.05
Barnyard Millet (fresh)	9 2	2.2	9.8	1.69
Hungarian Millet (fresh)	7.8	3 2	10.8	1 62
Millet ensilage (var. unknown)	5.2	2 8	12.4	1.37
Millet hay (var. unknown)	24.4	9.2	32.2	4.95
Millet Straw	13 6	3.6	34.6	3.52
Japanese Millet seed	34.6	13.8	7.6	5.15
Common Millet seed	40.2	19.2	9	6 02

Reputed Injuriousness of Foxtail Millet Forage.—In some sections of the country the foxtail millets have gained the reputation of being injurious to certain kinds of stock, and are therefore regarded with suspicion by many farmers and stockmen. Like many other forage plants, these millets become very harsh and woody with age, and are then difficult of thorough mastication and hard to digest. Then, too, at this stage of growth the beards are stiff and harsh, and are not only difficult to digest but produce more or less irritation in the digestive tract of the animal, and sometimes unite with other indigestible substances, forming compact balls in the stomach, ultimately causing death. However, if the hay is cut at the right stage of growth and properly cured, the action in either case will not be sufficient to lead to serious results if other hay or coarse forage is fed along with the millet. One feed of millet hay per day for work horses and one or two for other stock is sufficient, and when fed in

this manner the millet acts as a stimulant and alterative, and tends to produce and maintain a healthy condition of the animals.—(Dept. Agr. F. B. 101.)

Summary.—Millet is used chiefly as a "catch crop" for hay, since it can be sown in spring whenever it is discovered that a seeding of the permanent grasses has failed, or that a hard winter or insects have destroyed the clover. It may be sown when too late to plant corn. It requires good soil, preferably sand, and is especially adapted to new land. Sow half a bushel per acre for hay, one peck if for seed. The hay is usually cured by cocking it up when partially dry and allowing it to stand for several days before being hauled to the barn, as is often done with clover. The hay is strong feed and should be used with caution, being alternated if practicable with other fodder, especially if fed to horses. It is safer and more palatable if cut before the seed begins to ripen. Experimentation and breeding would in time no doubt remove any injurious quality now possessed by this valuable and much-needed forage crop. The best variety is German Millet, providing the soil is good and it can have the entire season. For late sowing, or poor soil, use Common Millet. Hungarian Grass on fertile soils, in a moist season, will give a large yield of excellent fodder.—(Mich. Agr. Exp. Sta. Special Bul. No. 2.)

GRASSES IN GENERAL.

The plains lying west of the one hundredth meridian, together with much broken and mountainous interior country, nearly treeless and arid, in New Mexico, Western Texas and Arizona are unreliable for the purposes of considerable ordinary agriculture, but are becoming more and more important for various crops as well as useful by being the great feeding ground for the multitudes of cattle which supply the wants of the more densely settled regions of the country as well as the constantly increasing foreign demand. The pasturage of this region consists essentially of native grasses, some of which have acquired a wide reputation for their rich, nutritious properties, their ability to withstand the dry seasons, and for their quality of self-drying or curing, so as to be available for pasturage during the winter season. This quality is due probably to the nature of the grasses themselves and to the effect of the arid climate. It is well known that in moist countries, at lower altitudes, the grasses have much succulence; they grow rapidly, and their tissues are soft; a severe frost checks or kills their growth, and chemical changes immediately occur which result in rapid decay; whereas in the arid climate of the plains the grasses have much less succulence, the foliage being more rigid and dry, and therefore when their growth is arrested by frost the tissues are not engorged with water, the desiccating influence of the climate prevents decay, and the grass is kept on the ground in good condition for winter forage. Apparently they only acquire this property on land which is 3,000 feet above the level of the sea. The region having such an altitude includes all nearly up to the timber line of Montana, Idaho, Wyoming, Utah, Nevada, Colorado, and New Mexico; five-sixths of Arizona, one-half of Dakota, one-fourth of Texas, one-fifth of Kansas, and one-sixth each of Cali-

fornia, Oregon, and Washington, embracing about one-fourth of the area of the whole United States.

Many of the grasses of this extensive region are popularly known as bunch grass, from their habit of growth; others are known as mesquite and grama grass. These consist of many species of different genera, some of them more or less local and sparingly distributed, others having a wide range from Mexico to British America.—(Dept. Agr. D. B. Special B.)

Hay Grasses.—Slender Wheat-grass (*Agropyron tenerum*).—A perennial bunch grass growing in the northern prairie region from Nebraska to Montana and Manitoba. Its sterling qualities for hay have long been recognized by Northwestern farmers. It produces an abundance of soft, leafy stems and root leaves, and ripens a large amount of seed that is easily gathered. Redtop (*Agrostis alba*).—The great variability of this grass has led to much diversity of opinion in regard to its value. The taller forms are largely cultivated for hay, being usually mixed with timothy and clover. This grass requires considerable moisture in the soil, and is one of the best for permanent pastures in the New England and Middle States. Meadow Foxtail (*Alopecurus pratensis*).—This well-known grass has been introduced into this country and cultivated to some extent in the New England and Middle States. It is a valuable grass for moist meadows and pastures, particularly the latter, on account of its early growth, being one of the earliest of the cultivated grasses. It is very hardy, and on good soil yields a large amount of excellent forage. Johnson-grass (*Andropogon halepensis*).—A stout perennial with smooth, erect clumps, 3 to 6 feet high, and strong, creeping rootstocks. The panicles are expanded during flowering and are from 6 to 12 inches long. It is a native of southern Europe and the warmer parts of Asia and northern Africa. It was introduced into this country about sixty years ago, and has now become widely distributed and well known throughout the Southern States. Big Blue-stem (*Andropogon provincialis*).—A stout perennial, with erect, more or less branching, and often bluish or glaucous stems, 2 to 6 feet high, long leaves, and flowers in short spikes. This grass has a wide range, extending over the United States east of the Rocky Mountains, and in the West and Northwest, particularly in the Missouri region, it is very abundant, and is highly valued for hay. Sorghum (*Andropogon sorghum sativus*).—Includes the cultivated varieties, a number of which have been recognized by some authors as distinct botanical species under the genus *Sorghum;* others have referred them all to the genus *Andropogon.* All the forms are of Eastern origin, and have arisen probably from a common stock through ages of cultivation. Tall Oat-grass (*Arrhenatherum elatius*).—A loosely tufted perennial, 2 to 4 feet high, introduced from Europe as a fodder grass and now quite generally distributed over the regions east of the Mississippi. It does well in the Southern States, where it is frequently cultivated, and is valued both for winter grazing and for hay. In California it is spoken of in the highest terms, particularly for its drought-resisting qualities. Mitchell-grass (*Astrebla pectinata*).—A smooth,

erect grass, with flat leaves and densely flowered terminal spikes or heads. It is regarded by stockmen as one of the best grasses, both for its drought-enduring qualities and for its fattening properties. If cut just when coming into bloom, it makes excellent hay. The seed is produced in abundance, and is easily collected. Oats (*Avena sativa*).—A well-known erect annual, 2 to 4 feet high, with flat leaves and expanded panicles of rather large pendulous spikelets. (See cereals.) Side Oats (*Bouteloua curtipendula*).—This has tough, perennial, fibrous roots, flat, long-pointed leaves, and many short spikes. Its range extends from New Jersey westward to the Rocky Mountains and southward through Texas into Mexico. Where abundant, it is said to make fair hay, and the numerous root leaves afford good pasturage. Japanese Wheat-grass (*Brachypodium japonicum*).—A promising perennial, closely resembling Bearded Wheat-grass, but of rather stronger growth. It was introduced into California from New Zealand, in 1886, and the first seed was distributed there in 1889. It has been cultivated with success. In the Southern States it is regarded as a valuable grass for winter grazing, as it makes its best growth during the cooler months. Smooth Brome-grass (*Bromus inermis*).—A native of Europe introduced into this country about 1880, which gives considerable promise of value both for hay and pasturage. Millet; Hungarian-grass (*Chætochloa italica*).—This grass, in some of its varieties, has been cultivated in the East for many centuries, and in some parts of India and Trans-Caucasia it still forms an important article of food. (See Millets.) Bermuda-grass (*Cynodon dactylon Pers*).—A grass widely dispersed over the tropical regions and warmer countries of the globe. It has a creeping habit of growth, extending over the surface of the ground and rooting at the joints. In poor soils the leaves are short and the upright flowering stems are only a few inches high, but on good land it grows to the height of 1 to 2 feet and yields a large amount of excellent hay. It may be cut three or four times during the season. In the Northern States it does not afford a profitable crop and is of little value for pasturage north of Virginia. Crested Dog's-tail (*Cynosurus cristatus*).—This is a native of Europe and is adapted to cultivation in moist, temperate regions, and has been sparingly introduced into this country. On moist, rich land it is fairly productive, but is rarely sown alone, excepting for seed or the formation of lawns, for which latter purpose it is well adapted, as it forms an even and compact sward when thickly sown. Orchard-grass (*Dactylis glomerata*).—This is one of the best known and most popular of our cultivated grasses. It will grow well on any soil containing a reasonable amount of fertility, excepting that which is very wet, anywhere in the United States, except in the extreme South and in the arid regions of the West. It yields an abundant crop of excellent hay, and may be sown alone for this purpose, but owing to its habit of forming tufts, or tussocks, the land should be seeded heavily or the seeds should be mixed with other kinds, to act as fillers or bottom grasses. It is a good pasture grass, especially for open woodlands, and affords excellent grazing earlier than almost any other species. The aftermath is unequaled in

amount by any of the grasses ordinarily cultivated for hay. Teff (*Eragrostis abyssinica*).—A branching, leafy annual, 2 to 4 feet high, with widely spreading capillary panicles of many spikelets. This grass grows readily from seed, which is produced abundantly, and it may be of some value for hay in parts of the South or Southwest. Teosinte (*Euchlæna mexicana*).—A stout, leafy, annual grass, 8 to 10 or 12 feet high, resembling Indian corn, to which it is botanically closely related. It has been cultivated in various parts of the South and West, has a habit of tillering, or sending up many—20 to 50—stalks from the same root. From this habit the bulk of fodder produced to the acre is very large, probably unequaled by any other grass. Tall, or Meadow Fescue (*Festuca elatior*).—This grass has been widely cultivated in this country, having been introduced from Europe, and has become thoroughly naturalized. It is an exceedingly valuable grass either for mowing or pasture. It is productive on soils which are not too dry, and, being of long duration, is especially valuable for permanent pastures. It thrives best on moist soils rich in humus, whether marls or clays. Barley (*Hordeum sativum*).—Cultivated barley presents many varieties, primarily divided into two-rowed, four-rowed, and six-rowed races. The varieties under these races are based upon the varied characters presented by the head, beards, or grain. (See cereals.) Italian Rye-grass (*Lolium italicum*).—A well-known and excellent grass for rich and rather moist lands, particularly for the Eastern States. It is a very rapid grower, forms a dense turf, and in Europe, whence the grass was introduced into this country, it is regarded as one of the best hay grasses. Perennial Rye-grass (*Lolium perenne*).—Perennial Rye-grass has been cultivated in England for more than 200 years, and is therefore one of the oldest if not the very first grass gathered and cultivated separately for agricultural purposes. It is indigenous to Europe, North Africa, and western Asia, and was many years ago introduced into this country from England. Rice (*Oryza sativa*).—A tropical or subtropical semiaquatic grass, the grain of which is the staple food of one-third of the human race. (See cereals.) Barnyard-grass (*Panicum crus-galli*).—This well-known annual of rank growth is common in rich, cultivated ground, especially around dwellings. There are several forms presented by this species. That growing as a weed around barnyards and dwellings, in cultivated grounds in the Atlantic States, was probably introduced from Europe. There are, however, several native varieties, or possibly good species. A tall, smooth form occurs in New Mexico, Arizona, and the Mohave desert region, springing up after the summer rains in all swampy places or lowlands. When sown for silage or for soiling at the rate of one peck of seed to the acre, the yield was at the rate of from 15 to 18 tons per acre. A field sown July 26, after a crop of hay was removed, yielded 12 tons per acre. Guinea grass (*Panicum maximum*).—This grass was long ago introduced into America, presumably from tropical Africa, and has for many years been cultivated in tropical South America and the West Indies. In these regions it is spoken of as being a splendid pasture grass, growing to the height of 12 feet, forming

dense tufts. It is readily propagated by cuttings of the creeping rootstocks. It has been introduced into some of the Gulf States, particularly Florida, where it is highly valued. Broom-corn Millet (*Panicum miliaceum*).—A rather coarse annual, attaining a height of 2 to 4 feet, with large, drooping, loosely flowered panicles. (See millets.) Para-grass (*Panicum molle*).—A rather coarse, reed-like perennial, 4 to 6 feet high. It is cultivated in South America, and in the West Indies and Mexico, and has been introduced into some of the Gulf States. It is grown with success on the high pine ridges of Florida, and wherever cultivated it is most highly esteemed and regarded as a very fattening pasture grass. Crab-grass (*Panicum sanguinale*).—A well-known annual, common in nearly all parts of the United States, growing in cultivated fields and about dwellings. It is a weed in gardens and among hoed crops. In grain fields after harvest it frequently springs up in such quantity, particularly in the Southern States, as to yield one or even two good cuttings of hay. The stems are much branched, and in good soil attain a length of 3 to 4 feet. This grass contains little fiber, and dries quickly when cut, but if after cutting it is wet by rains or heavy dews its value for hay is almost wholly destroyed. Texas Millet (*Panicum Texanum*).—This grass is a native of Texas. It is frequently called Colorado grass, from its abundance along the Colorado River in that State. In some localities it is known as river grass; in others as goose grass, from its being supposed to have been introduced by wild geese. In southern Texas it is sometimes called buffalo grass. Pearl Millet (*Pennisetum spicatum*).—This is supposed to be a native of Africa, but has been known from time immemorial in cultivation in India, Arabia, and Egypt. (See millets.) Reed Canary Grass (*Phalaris arundinacea*).—A perennial grass, with strong, creeping rhizomes, growing from 2 to 5 feet high, usually in low or wet ground. It ranges from New England and New York westward to Oregon, and northward to Canada, also in the mountainous parts of Pennsylvania and Virginia. It is common also in the north of Europe. Timothy (*Phleum pratense*).—This is one of the commonest and best-known grasses. For a hay crop it is extensively cultivated, especially in the Northern and Western States. (See timothy.) Kentucky Blue-grass (*Poa pratensis*).—This is apparently native throughout the temperate regions of the northern hemisphere. It ranges from Labrador to South Carolina, westward to the Pacific Coast and northward to Alaska. In the limestone regions of Kentucky and Tennessee it attains its greatest perfection and is there regarded as the king of pasture grasses. It requires a good soil containing some lime in order to yield profitable crops. It is largely employed in the Eastern and Middle States as a lawn grass, for which use it is well adapted. It makes a good, firm sod, and is particularly well suited for turfing the slopes of terraces and embankments, where the soil is good. Sugar Cane (*Saccharum officinarum*).—A stout grass with many-jointed stems, 8 to 15 feet high, broad leaves, 3 to 4 feet long, and long (16 to 32 inches), pyramidal panicles. (See sugar cane.) Yellow Oat-grass (*Trisetum pratense*).— A rather slender, loosely

tufted perennial, growing to the height of 2 feet. It is a native of Europe, northern Africa, and western Asia. It occurs along roadsides, in open fields, and on grassy mountain slopes, where its presence is said to indicate land of good quality. In Europe, Yellow Oat-grass is classed with the best fodder plants and is highly valued for temporary, but more particularly for permanent, pastures. It can be grown on almost every variety of soil, is fairly productive, and is readily eaten by stock. Wheat (*Triticum æstivum*).—Wheat in its many varieties is one of the most important of the true grasses. It is one of the oldest of the cultivated cereals, the grains having been found in very ancient Egyptian monuments, dating back to 2,500 or 3,000 B. C. (See cereals.) Indian Corn or Maize (*Zea mays*).—One of the most valued of the cultivated cereals. The many varieties which have originated in cultivation have been variously classified. They differ much in the form, size, color, and hardiness of the grain, and in the time required for ripening. (See corn.)

Pasture Grasses.—Wire Bunch-grass (*Agropyron divergens*).—A slender, usually densely tufted perennial, with very narrow, spreading leaves, and bearded or beardless spikes. This grass is common in the Rocky Mountains and Pacific Slope regions, extending westward to the coast. Herd's grass; Redtop (*Agrostis vulgaris*).—Mentioned elsewhere. Timothy is called Herd's grass from Timothy Herd who first called the attention of the world to its value. The term has been applied by several writers to redtop, owing perhaps to its close association with timothy. Creeping Bent (*Agrostis stolonifera*).—By some regarded as only a variety of *Agrostis alba,* with long, prostrate or creeping stems, well adapted for sandy pastures near the coast, and useful, perhaps, for binding shifting sands or river banks subject to wash or overflow. It makes a good pasture grass for low lands, especially for those which are somewhat sandy, and produces a fine and enduring turf for lawns, for which it is especially well adapted. Bushy Blue-stem (*Andropogon nutans*).—This is a stout perennial, 4 to 6 feet high, growing in dry soil along the borders of fields and open woods, and on the prairies of the West it often forms a large proportion of the so-called prairie hay. It is held in little esteem in the Eastern and Southern States, but in the West it is said to make excellent hay, and is particularly valuable because of the relatively large amount of long root-leaves which it produces. Big Blue Stem.—(See hay grasses.) Little Blue-stem (*Andropogon scoparius*).—A rather slender perennial. This grass has a similar range to the Big Blue-stem, extending over nearly all of the United States east of the Rocky Mountains, and in the prairie regions it is nearly always found associated more or less abundantly with the Big Blue-stem and Bushy Blue stem. Needle-grass (*Aristida fasciculata*).—Needle-grass grows from 6 inches to a foot high, and is a native of the arid regions, from Montana southward to Texas, where it is particularly abundant in poor soils, and presents a great variety of forms. It is usually found in dry, gravelly soils on the plains, mesas, and foothills. Side Oats Grama.—(See hay grasses.) Black Grama (*Bouteloua eriopoda*).—This is one of the species of Grama so valuable for

grazing in New Mexico and Texas. It is a common grass along the Rio Grande and in the region between the Pecos and the Gila; also in the Olympia, Guadalupe, and Eagle Mountains, and on the Staked Plains in Texas. Blue or White Grama (*Bouteloua oligostachya*).—This is one of the most abundant and most valued of the Grama grasses, and extends from Wisconsin westward to California, and southward into Texas and northern Mexico. It is a perennial, 6 to 18 inches high, its strong rhizomes and numerous root-leaves forming dense and more or less extensive patches of excellent turf. In Montana it is known as Buffalo-grass. It frequents the bench lands of that State, growing at elevations of from 3,000 to 4,000 or 5,000 feet, and not infrequently covers wide areas. No other grass better withstands the tramping of stock, and it is unsurpassed for grazing purposes. Japanese wheat grass.—(See hay.) Rescue-grass (*Bromus unioloides*).—This *Bromus* is a strong-growing grass, with rather broad, much flattened, usually bearded spikelets. It grows to the height of 1 to 3 feet, and in the more vigorous plants the branches of the nodding panicle are widely spreading. It grows rapidly, seeds freely, and dies after seeding. If, by frequent mowing or close grazing, it is prevented from going to seed, its duration may be continued over two or three years or more. If the seeds are allowed to fall, as they frequently do when mature, young plants soon appear, and a fairly continuous growth of this grass may thus be maintained. Smooth Brome.—(See hay.) Buffalo grass (*Bulbilis dactyloides*).—This is the true Buffalo-grass of the Great Plains region, which is reported to have been much more abundant and more widely distributed in times past than it is at present. Now, however, it is known to extend from the British Possessions southward into Texas, where it is considered an invaluable grass and one of the best constituents of sheep pastures. Windmill-grass (*Chloris verticillata*).—A low, spreading perennial, with upright flowering branches 6 to 20 inches high. The small awned spikelets are in slender spikes, which are crowded near the apex of the stems, and become widely spreading at maturity. This grass is common in many places in central Texas, New Mexico, Arizona, northward to Kansas, and by some is spoken of very highly as an excellent grass for grazing, and one not easily tramped out. Bermuda grass.—(See hay.) Everlasting-grass (*Eriochloa punctata*).—A quick-growing, smooth, succulent perennial, 2 to 3 feet high, with flat leaves and narrow panicles 2 to 4 inches long. Widely distributed within the tropical and subtropical regions of both hemispheres. This grass deserves the attention of Southern dairymen. In Arizona it grows throughout the valleys in irrigated soil, or in the rich moist places of the plains, yielding abundant herbage eagerly sought by all kinds of stock. Indian Millet (*Eriocoma cuspidata*).—A grass of rather striking appearance, 1 to 2 feet high, widely distributed throughout the Rocky Mountain region from British America southward to Texas and New Mexico, eastward to the Missouri, and westward to the Sierras of California. It grows in dry, sandy soils, forming bunches of greater or less size, and from this habit of growth it has been called, along with a num-

FIG. 1.—NITROGEN-FIXING NODULES OF ALFALFA.

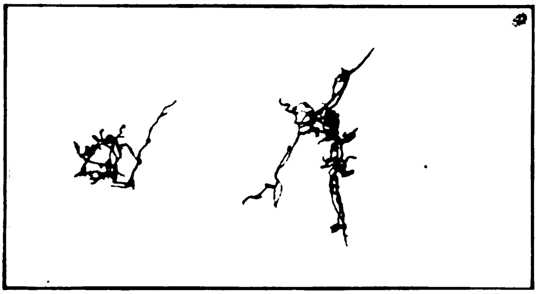


FIG. 2.—CROWN-GALL TUMORS OF CRIMSON CLOVER.

FIG. 3.—NITROGEN-FIXING NODULES OF CRIMSON CLOVER.

FIG. 2.—CROWN-GALL TUMORS OF ALFALFA.

ber of other grasses, "Bunch-grass." It thrives in soil too dry and sandy for the growth of most other grasses, and is much esteemed for grazing in the regions where it abounds. Hard Fescue (*Festuca duriuscula*).—A slender, densely tufted, perennial grass, 1 to 2 feet high, with numerous very fine radical leaves and open panicles. Fall Fescue.—(See hay.) Sheep's Fescue (*Festuca ovina*).—This species has many varieties both in this country and in Europe. It is indigenous in the mountainous parts of New England, in the Rocky Mountains, and in various northern localities. Red Fescue (*Festuca rubra*).—This is regarded as one of the most valuable grasses for dry, sandy meadows. Owing to the great production of fine root leaves, this species makes a good bottom grass, and as these leaves are quite soft the grass is well adapted for lawns, and is particularly recommended for those which are too much shaded for the successful growth of other lawn grasses. It is an excellent grass also for woodland parks where the soil is not sandy. Indian Wheat (*Panicum ciliatissimum*).—A more or less extensively creeping perennial, with short leaves and upright flowering stems, 6 to 18 inches high. This grass is a native of western Texas, and doubtless possesses some agricultural value for the drier regions of the Southwest. The creeping stems resemble somewhat those of Bermuda-grass, but the leaves are usually more crowded and broader in proportion to their length. Perennial eye grass.—(See hay.) Curly Mesquite (*Hilaria cenchroides*).—A delicate perennial with slender, creeping stems, the upright, leafy shoots a few inches to nearly a foot high. This is one of the most valuable of the grasses of the dry plains and mesas of the Southwest. It forms a dense, green sward, and in habit of growth closely resembles the true Buffalo-grass. It has the habit of creeping over the ground and rooting at the joints of the stems, from which spring leafy branches that in turn reach out for other places in which to take root. Carpet-grass (*Paspalum compressum*).—A slender, erect, or more frequently prostrate and extensively creeping perennial, rooting at the nodes, and sending up numerous leafy, flower-bearing branches, 6 to 24 inches high. The very slender racemes or spikes borne at or near the summit of the stems are 1 to 3 inches long. The prostrate creeping stems spread rapidly, and soon form a dense, carpet-like growth, crowding out all other vegetation. It withstands protracted drought, grows well on almost any soil, and in the more southern districts is evergreen, yielding good pasturage both summer and winter. It is regarded as one of the most valuable native pasture grasses of the regions bordering the Gulf. Canadian Blue-grass (*Poa compressa*).—This grass has extensively creeping rootstocks, and forms a strong turf. It is closely related to Kentucky Blue-grass, but it is more decidedly blue in color, and is readily distinguished from that species by its strongly flattened stems, lower habit of growth, and smaller panicle. It is the "Blue-grass" of the farmers of the New England and Middle States. It will grow upon a great variety of soils, even upon those so poor and thin as to exclude the growth of other grasses. In cultivated lands it is likely to become troublesome, owing to its creeping rootstocks. There is perhaps no

better pasture grass for dry and poor soils, particularly in the Eastern and Middle States. It is especially valuable for dairy pastures; cows feeding on it yield the richest milk and finest butter. Kentucky Blue-grass.—(See hay.) Rough-stalked Meadow-grass (*Poa trivialis*).—An erect perennial, closely related to Kentucky Blue-grass, from which it differs in having no conspicuous rootstock and the stem distinctly rough below the panicle. It succeeds best where the climate and soil are rather moist and cool, but is not adapted to dry soil. Rye (*Secale cereale*).—An annual, 4 to 6 feet high, with flat leaves and a terminal, somewhat flattened, bearded spike 4 to 6 inches long. (See cereals.) St. Augustine-grass (*Stenotaphrum dimidiatum*).—This grass has a wide distribution, being found in the tropical and warmer temperate regions of both the Old and New World. In New South Wales it is known as Buffalo-grass, and in Jamaica it is called Pimento-grass. It grows upon every variety of soil, from the apparently sterile sand dunes to heavy clays, but is rarely found far away from the coast. The flattened stems emit fibrous roots at every joint, where they also readily separate, each piece becoming a new center of growth. St. Augustine-grass grows along our ocean shores as far north as South Carolina, and is extensively used for lawns in Charleston, S. C., and cities in the South near the coast.

Lawn Grasses.—Sea-coast Bent (*Agrostis coarctata*).—A creeping perennial with slender culms, the upright branches 1 foot high, short and narrow flat leaves, and densely flowered panicles 2 to 4 inches long. It grows in damp soils and sands along the sea coast from Newfoundland to New Jersey, often occurring where constantly drenched by the flying salt spray. It is a fine-leafed, excellent turf-forming species, valuable for lawns. A similar if not identical species is common in western Oregon and Washington. Rhode Island bent, or dog-grass (*Agrostis canina*).—A grass usually of low size, 6 to 12 inches high, with slender culms, and a light, flexible, expanded panicle, and with a perplexing variety of forms. There are several varieties growing in mountainous regions throughout the United States, and in Europe. It forms a close sod, and affords considerable pasturage in those regions. Various leafed Fescue (*Festuca heterophylla*).—A rather slender European grass, 2 to 4 feet high, with very narrow root-leaves, and narrow but flat culm leaves. It is a perennial, closely related to Creeping Fescue, of which it has been made a variety by some authors. It makes its best growth on low-lying lands which are not too dry, but upon good soil it withstands protracted periods of drought very well. Mexican Lawn-grass (*Fourniera mexicana*).—A low, extensively creeping grass that grows in the mountain valleys of western Mexico. Stock eat it with avidity. An excellent lawn and pasture grass for subtropical regions. Mexican Lawn-grass (*Opizia stolonifera*).—A creeping grass, the very slender, prostrate stems sending up leafy tufts 1 to 4 inches high. Similar in habit to Bermuda, but more delicate. Growing close to the ground, it forms a thick sod over all exposed surfaces, even over the cobblestones in the streets of towns. It is used in the public squares with good effect. By regular watering it is easily kept green, and but little

cutting is necessary. The seed is difficult to obtain, owing to the constant nibbling of domestic animals. Propagation by cuttings of the rooting, prostrate stems is probably the best method. Japanese Lawn-grass (*Zoysia pungens*).—A creeping maritime grass growing on the sandy shores of tropical and eastern Asia, Australia, and New Zealand. In Australia it is considered an excellent sand-binder, and, while valuable for this purpose, it is at the same time an excellent forage plant. Also: Creeping bent, Buffalo g., Bermuda g., red fescue, carpet g. and St. Augustine g., mentioned before.

Grasses for Wet Lands.—Cane (*Arundinaria macrosperma*).—This is the bamboo which forms the well-known canebrakes of the South. It is perennial, with woody stems 10 to 30 feet high, and evergreen leaves, which furnish a valuable supplement to the winter pastures. The plant blooms but once, and when the seeds mature the cane dies. The canes are used for many purposes, such as fishing rods, scaffolds for drying cotton, splints for baskets, mats, etc. Attempts made to cultivate this grass have not been successful. Reed (*Arundo donax Linn*).—A tall, leafy perennial, attaining the height of 10 to 15 feet, or in very favorable locations even 30 feet. The leaves are broad and widely spreading and the stems are leafy to near the top. The panicle has some resemblance to that of pampas grass, but is not so large. This grass is grown for lawn decoration and to conceal unsightly objects. It is a native of southern Europe, northern Africa and western Asia, and is said to be spontaneous along the Rio Grande. In some countries the stout stems are used for laths and, when split, for woven work; the leaves are used for thatch or roofing, and the stout rhizomes are employed as a diuretic. A cultivated variety has its broad leaves striped with longitudinal white bands. It presents a very striking appearance. This grass is propagated by transplanting the roots, which work may be done at any time during the season. Blue-joint (*Calamagrostis canadensis*).—A native grass common in the Northern and Northwestern States, extending clear across the continent, usually growing in moist meadows. The leafy stems are 3 to 5 feet high, and the open brown or purplish panicles have some resemblance to those of Redtop. Occasionally it is found occupying considerable areas to the exclusion of other grasses, and under such conditions it yields a large amount of excellent hay, highly prized by farmers and eaten with avidity by all farm stock. This grass grows naturally on low, moist meadows, and has succeeded well under cultivation. In the northern portion of the United States its more extended culture for hay is recommended. Yellow Foxtail (*Chætochloa glauca*).—An erect annual, 1 to 2 feet high, with flat leaves and a bristly, cylindrical, spike-like, densely-flowered panicle 1 to 3 inches long. This grass is widely distributed throughout the tropical and warmer temperate regions of the world, growing best on the lands along the coast. Salt-grass (*Distichlis spicata*).—An upright, wiry grass, 10 to 20 inches high, with strong, extensively creeping rootstocks. Common along the coast on both sides of the continent, and abundant in the alkaline regions of the interior, where it is often found covering considerable

areas to the exclusion of other grasses. It thrives even in ground heavily crusted with alkali and other salts sufficient to destroy almost any other kind of vegetable growth. Prospectors and miners consider its presence a sure sign of water near the surface, and when crossing a desert select spots where it grows to dig for water. In farming lands it is deemed a nuisance. Velvet-grass (*Holcus lanatus Linn*).—A perennial, with a creeping rootstock, and stems and leaves clothed all over with a soft, whitish pubescence. This grass has been introduced into this country from Europe, and has become naturalized in many places. It possesses little nutritive value, and is not well liked by stock, particularly horses. It possesses some value, however, on peaty or sandy soils where the better grasses will not grow. Reed Meadow-grass (*Panicularia americana*).—A stout, erect, leafy perennial, 3 to 4 feet high, with long, rather broad leaves, and a large, nodding panicle. It is common in the northern Middle States and southward along the mountains to Tennessee and North Carolina, extending westward to the Rocky Mountain region. Floating Manna-grass (*Panicularia fluitans*).—This grass grows to the height of from 3 to 5 feet, and has a narrow panicle composed of rather few long and narrow or cylindrical spikelets. It is a cosmopolitan species, found in all temperate regions of the world, and is regarded as one of the best fodder grasses for swampy meadows. Fowl Meadow-grass (*Panicularia nervata*).—A leafy perennial, 1 to 3 feet high, with expanded nodding panicles of small spikelets. This is a common species in low meadows and moist grounds, extending from New England southward to the Gulf States and westward to the Pacific coast. It is a good fodder plant for moist meadows. Knotgrass (*Paspalum distichum*).—A low creeping species, resembling Bermuda-grass. It is common in the Southern States along the seacoast and in the interior, extending southward from Virginia to the Gulf, and westward to Texas, Arizona, southern California, and northward to Oregon. False Red-top (*Poa flava*).—A native of northern Europe and the northern portions of this country, growing naturally in wet meadows and along the low banks of streams. It attains the height of 2 to 3 feet, or even 4 feet in rich, moist soils, and has an expanded, nodding panicle of rather small, purplish, or "bronzed" spikelets. It is found in nearly all parts of New England, and often forms a very considerable and valued portion of the native hay of the low meadows. Wild Rice (*Zizania aquatica*).—A tall, erect annual, 3 to 10 feet high, growing in shallow water along rivers and lakes from Canada southward to Florida and westward to Texas. The grain is a favorite food of the reed bird, and the grass is cultivated to some extent by sportsmen with a view to attracting these and aquatic fowl. It grows very rapidly in 1 to 8 feet of water, and matures its seeds in August or early in September. It succeeds best when sown in the fall broadcast in 2 or 3 feet of water having a muddy bottom, but it can be sown in the spring in water from 6 inches to 5 feet deep. Before sowing soak the seeds in water twenty-four hours. This grass is the *Manorrin* of the Chippewa Indians, who gather the grain for food. Also: Redtop, seacoast bent, creep-

ing bent, red fescue, Italian rye, rice, Para g., carpet g., seed canary, timothy and St. Augustine grass, cited before.

Grasses for Holding Shifting Sands.—Beach-grass (*Ammophila arenaria*).—This grass grows more or less abundantly along the sandy coasts of the Atlantic and the shores of the Great Lakes. It has strong, creeping rootstocks, upright stems 2 to 4 feet high, and long, rather rigid leaves. The narrow, densely flowered panicles which terminate the stems are from 3 to 10 inches long. It is one of the most valuable grasses adapted to binding the drifting sands of our coasts, and has been cultivated for this purpose in this as well as in other countries. Turkey-foot-grass (*Andropogon hallii*) was observed only in the sandhill region of western Nebraska. Here it produces an exuberant growth, 4 to 6 feet high, with a large number of leaves. It should be cut early if used for hay. Cattle are fond of the grass when young and fatten on it. Many farmers believe that for range purposes the sandhills are much superior to the country east, and Turkey-foot is one of the most important grasses of the region. Sea Lyme-grass (*Elymus arenarius*).—A stout, coarse grass, one of the best grasses known for binding the drifting sands of the coast, and in northern Europe has been cultivated along with Beach-grass for this purpose. These two grasses when combined seem admirably adapted for the purpose of forming a barrier to the encroachment of the sea; the sand that Beach-grass arrests and collects about itself the Lyme-grass secures and holds fast. The seeds are used for food by the Digger Indians of the Northwest, and as the grass springs up around their deserted lodges it is called by the settlers "*Rancheria*" grass. Soft Sea Lyme-grass (*Elymus mollis*).—A grass which closely resembles and has the same habit of growth as *Elymus arenarius*. It is distinguished by having the stem soft-downy just below the head or spike and in having five to seven flowered spikelets, the outer glumes of which are broader and five to seven nerved. This grass occurs along the shores of the Great Lakes and northward on both the Atlantic and Pacific coasts. Mexican Salt-grass (*Eragrostis obtusiflora*).—A rigid perennial, 12 to 18 inches high, with strong and extensively scaly rootstocks, stiff and sharp-pointed leaves, and more or less spreading panicles. Abundant in the highly alkaline soils of Sulphur Springs Valley, Arizona, where the large rootstocks serve to bind the shifting sands. In the absence of other grasses it is eaten by stock. Blow-out grass (*Muhlenbergia pungens*).—A rather rigid perennial, has strong, creeping roots, and often does good service as a sand binder. In the sandhills region of Nebraska it grows abundantly around the borders of the so-called "blow-outs," preventing their extension and assisting materially in restoring the turf. In some parts of Arizona where it occurs it is esteemed a valuable forage plant. It grows from Nebraska southward to New Mexico and Arizona, and along the Colorado River above Fort Yuma. Bitter Panic-grass (*Panicum amarum*).—A grass of the sandy sea-coasts, ranging from Connecticut southward to Florida and along the Gulf. It has coarse, hard stems, 1 to 5 feet high, and strong, creeping rootstocks, making it an excellent sand binder. Redfield's-grass

(*Redfieldia flexuosa*).—A stout, native perennial, 18 inches to 4 feet high, with long, narrow leaves and diffusely spreading panicles, growing in the sandy districts of Nebraska, Colorado, and Kansas. It has deeply penetrating and widely spreading underground stems or rhizomes, making it a valuable species for binding drifting sands. It is a characteristic grass of the sandhills of central Nebraska, growing in the drifting sands and "blow-outs," and is a conspicuous and almost the only grass found on the sand-dunes south of the Arkansas River, near Garden City, Kans. Fox-grass (*Spartina patens*).—A rather slender species, 1 to 2 (rarely 3 to 4) feet high, with two to four slender, erect, or widely spreading spikes. This is common upon the salt marshes, and is one of the most valued species which go to form the salt hay that these marshes produce. It ranges from Maine southward to Florida and along the Gulf coast to Texas. It is useful for packing glassware, crockery, etc., and in the larger towns along the coast is much used for this purpose. Seaside Oats (*Uniola paniculata*).—A native, with stout, erect stems 3 to 5 feet high, long, rigid leaves, and showy nodding panicles of broad, pale straw-colored spikelets. The panicles are gathered for dry bouquets, and are often seen in our markets, along with the plumes of Pampas-grass. It grows in the drifting sands along the seashore, just above high tide, from Virginia southward to Florida, and along the Gulf Coast westward to Texas. It is an excellent sand binder, its rootstocks being very strong and penetrating deeply into the soil, much like those of Beach or Marram grass, of which it is a southern analogue. The leaves are sometimes cropped by cattle, but the grass is too tough and dry to be of any importance as a forage plant. Also: Seacoast bent, sand g., Bermuda g., blady g., creeping panic, St. Augustine g., and Japanese lawn g.

Grasses for Embankments.—Couch Grass; Quack Grass (*Agropyrum repens*).—There has been a good deal of discussion relative to this grass, some pronouncing it one of the vilest of weeds, and others claiming for it high nutritive qualities overweighing all the disadvantages of its growth. Whichever party may be right, it is proper that farmers should be acquainted with it in order to know how to treat it, and hence this description. It forms a dense sod by means of its far-reaching rhizomes or rootstocks, which have short joints, and roots tenaciously at every joint. It has an abundance of foliage, and sends up a flowering culm 2 to 3 feet high, which is terminated by a close, narrow spike of flowers from 3 to 6 inches long. This spike consists of a succession of closely set spikelets, one at each joint of the axis, and placed flatwise with the side against the stalk. Each spikelet contains several (three to eight) flowers, with a pair of nearly equal and opposite three to five-nerved glumes at the base. Vetivert (*Andropogon squarrosus*).—A stout perennial, 4 to 6 feet high, with strong, fibrous, and highly fragrant roots. A native of India, occurring also in some of the West India Islands and Brazil, growing in marshes and on river banks. Introduced into Louisiana many years ago, and now spontaneous in some of the lower parts of that State. Big Sand-grass (*Calamovilfa longifolia*).—This grass

has no agricultural value, but from time immemorial its utility in binding together the loose sands of the beach, and restraining the inroads of the ocean, has been recognized and provided for in some places by law. Blady-grass (*Imperata arundi*).—A sand and soil binder common throughout the warmer temperate and tropical regions of both hemispheres. It is a stout, erect, leafy grass. The rootstocks form a perfect network of strong fibers, and in warm countries the grass is recommended for binding river banks, the sides of dams, and the loose sands of the coast. This grass is easily propagated by root cuttings. Maiden Cane (*Panicum digitarioides*).—A rather coarse grass, growing along ditches, in swamps, and in moist sands from Delaware southward to Florida, and along the Gulf near the coast. It has strong and widely spreading or creeping rootstocks, which are useful in binding sandy railroad embankments in the Southern and Gulf States. Vine Mesquite (*Panicum obtusum*).—This grass ranges from Colorado to Texas, New Mexico, Arizona, and southward into Mexico. It is usually found in irrigated lands or in the low, damp soil of the valleys, most frequently under the shade of trees and shrubs. No attempts have been made to cultivate this grass, but its appearance and habit of growth indicate an agricultural value of sufficient importance to call for experiments in its cultivation. In New Mexico this species is called "Wire-grass." Creeping Panic (*Panicum repens*).—An extensively creeping grass, with rather stiff upright stems. It is common in the maritime districts in southern Asia, northern Africa, southern Europe and Australia. It is also found along the shores of the Southern States bordering the Gulf, extending westward to Mexico. It has no agricultural value, but is a natural sand binder. Upon the sandy islands lying off the Gulf Coast it grows abundantly upon the outside of dunes, protecting them from the action of the winds and waves. Reed Canary-grass.—See h. g. Common Reed (*Phragmites vulgaris*).—This is one of the largest of our native grasses, growing to the height of 12 feet, the rather stout culms bearing numerous broad, spreading, and sharply pointed leaves, 1 to 2 feet long. It has deeply penetrating and extensively creeping rootstocks, making it one of the most valuable grasses for binding the banks of rivers subject to periodical floods. It is occasionally found along the coast in brackish marshes and sometimes upon sandy soils, and possibly may be employed with advantage for binding drifting sands or those liable to be shifted by high tides. Cord grass (*Spartina cynosuroides*).—Stout, with erect, simple stems 2 to 9 feet high, flat and long-pointed leaves, and numerous erect or spreading spikes 2 to 5 inches long. This is a native, common along our ocean and lake shores, borders of rivers, etc., ranging from Maine to the Carolinas, and westward to the Pacific. It makes a fair but rather coarse hay when cut early, and has been successfully employed in the manufacture of twine and paper. The strong, creeping, scaly rootstocks of this grass adapt it for binding loose sands and river banks, and in the West it is used for thatch. Also: Johnson g., red fescue, salt g., Bermuda g., cane, smooth brami, knotgrass, carpet g., St. Augustine g., and Japanese lawn.

FODDER AND FORAGE PLANTS.

(Exclusive of Grasses)

There are in the United States over two hundred native wild species of the class locally recognized as excellent forage plants. More attention should be given the natives, for there is every reason to believe that among them are many kinds fully equal in productiveness and feeding value to any of those now under cultivation, and possibly many superior to anything now used in their adaptability to certain soils or climates or in their value for special uses. The Department of Agriculture could do no better than to continue on a larger scale experimentation with these varied and excellent forage grasses. It is interesting to note that of the 236 species briefly described below, all of which are natives (or if brought from foreign lands they have been sufficiently tried at either National or State Experiment Stations to receive recognition), about 150 belong to the legume or clover family and about 30 are salsolaceous plants, or salt-bushes. The former includes alfalfa, the vetches, peas, beans and clovers, and the latter the now well-known Australian salt-bush and other plants especially adapted to cultivation on alkali soils.

Many of the plants mentioned below are in some localities given local names; for instance, Mammoth clover is given no less than thirty-one different names in the index of Bulletin No. 2, Division Agrostology, Dep. of Agr., everyone of which refers to Number 288, the description of the variety just mentioned. The compiler deemed it sufficient to give generally the recognized popular name in the vernacular (English) followed by the botanical (Latin) name. The forage plants of special importance are more extensively described elsewhere in this volume, while a few of strictly local import only receive some mention in their proper place.

Abrosia (*Abrosia latifolia.*)—A low vine with viscid stems, thick, fleshy leaves and an enormously thickened spongy root. Grows on the sand-dunes along the coast of Oregon and Washington and furnishes some pasturage for cattle. Alaska Vetch (*Vicia sitchensis*).—A native of the Pacific coast from California to Alaska; valuable for forage, and deserves cultivation. Alfalfa (*Medicago sativa*).—Described under separate head, elsewhere in this work. Alfilaria (*Erodium moschatum*).—An annual of value in pastures on the Pacific slope. American Gray Bush (*Kochia americana*). —A perennial saltbush; one of the best winter forage plants in Wyoming. Annual Saltbush (*Atriplex holocarpa*).—A low, densely branching annual valuable in the grazing regions of the West and Southwest as far north as Colorado and Utah. Apache plume (*Fallingia paradoxa*).—A low undershrub of west Texas and New Mexico; browsed by cattle and sheep. Arrowgrass (*Triglochin maritimum*).—A marsh plant along the Atlantic coast which adds some value to the herbage of wet plants.

American Vetch (*Vicia americana*).—A smooth perennial with compound leaves, elliptical or oblong obtuse leaflets, and four

to eight purple flowers on elongated flower stalks. It grows in moist soil from New York westward to the prairie region. Stock are very fond of it and fatten in pastures where it is abundant.

Artichoke (*Helianthus tuberosus*).—Fed to milch cows these tubers, which contain a large amount of sugar and gum, greatly increase the flow of milk. The leaves are also greedily eaten by all kinds of stock. Artichokes are planted like potatoes, but at greater distances apart, and the yield is from 200 to 500 bushels per acre. On rich and friable soils it yields uninterruptedly for several years without replanting. Artichokes are of most value as food for hogs, which may be penned on the field and allowed to harvest the crop themselves.

Australian Saltbush (*Atriplex semibaccata*).—Australian saltbush is a much branched perennial, which forms a thick mat over the ground a foot thick. The branches extend from 6 to 8 or 10 feet, so that one plant will often cover an area 20 feet in diameter. The leaves are about an inch long, broadest at the apex, and coarsely toothed along the margin. They are fleshy and somewhat mealy on the outside. The pulpy, flattened fruits are tinged with red at maturity, but dry out as soon as they fall from the plant. They are produced in enormous numbers and ripen continuously for three or four months, or under some climatic conditions, throughout the year. At the California Experiment Station it was determined that the seeds germinate better when sown directly on the surface without any covering. When they were harrowed in to the depth of 2 or 3 inches most of them either rotted before germination or the young seedlings were unable to reach the surface. Some practical stockmen have had good results in establishing this saltbush on an alkali range by sowing the seed on the ground when it was wet with heavy rains and at once driving a flock of sheep over the land, thus treading them into the soil. Sheep are especially fond of this saltbush, and cattle relish it if combined with other feed. Many of the valuable qualities of the Australian wools are said to be due to the abundance of this and other saltbushes in the regions in which the sheep are grazed. The plant may be propagated by cuttings, as well as from seed, and this method is to be preferred wherever the land contains much alkali. The seeds will germinate in the presence of an amount of soda salts which would entirely prevent the growth of cereals. This saltbush is perennial in California, Arizona, and New Mexico, but must be treated as an annual wherever the winters are severe. In South Dakota plants from seed sown in May had just commenced to blossom at the time of the first hard frost in autumn. This is the most promising of the Australian saltbushes for cultivation in this country, both because of its hardiness and the bulk of fodder produced. The forage contains 11.6 per cent of crude protein in the air-dry substance as compared with 14.3 per cent for alfalfa. Thus, 100 pounds of the dry substance will contain 8.7 pounds of digestible crude protein as compared with 10.6 pounds in alfalfa.

Balsam-root (*Balsamorhiza deltoidea*).—A stemless perennial

of the arid plains of eastern Washington and Oregon, appearing in early spring; it is much sought by stock. Beach Pea (*Lathyrus maritimus*).—A perennial legume growing on pebbly beaches from Oregon to Alaska; it is greedily eaten by cattle. Beckwith's Clover (*Trifolium beckwithii*).—A native of the eastern Rocky Mountain and Upper Missouri prairie regions; it is much relished by stock. Bed Straw (*Galium*).—There are a number of these in New Mexico; it is highly regarded as forage for sheep. Beggarweed (*Desmodium*).—There are various kinds of beggarweed; it is a valuable forage plant, growing in rich woods from Canada to the Gulf. Big Headed Rush (*Juncus nodosus*).—This rush is common in boggy places in the prairie region and is of some value as early pasturage. Birdsfoot Clover (*Lotus corniculatus*).—A low, prostrate clover that will grow on the lightest and most sterile soils; cattle and sheep are fond of it; because of its deep roots it withstands drought and is an excellent clover to sow in mixtures with taller growing species in dry pastures. Beggarweed (*Desmodium tortuosum*).—An annual leguminous plant in Florida and the Gulf States. This is undoubtedly one of the very best forage plants for light, sandy soils. The stems are tall, and if grown at considerable intervals are woody, but where seed is scattered thickly over the ground the entire plant can be converted into hay or silage. Florida beggarweed springs up naturally in fields wherever the ground has been disturbed, about the middle of June, and matures a crop in seventy to eighty days. In the rich, moist, sandy fields along the Gulf of Mexico it grows from 6 to 10 feet high. Horses, cattle, and mules are very fond of it. According to analyses of beggarweed made at the Florida Experiment Station, 100 pounds of hay consisting of the upper portion of the plant, mainly leaves and branches, contained, before maturity, 19.42 pounds of crude protein and 65 pounds of carbohydrates; and when seed was ripening, 15.75 pounds of crude protein and 69.15 pounds of carbohydrates. Analyses at the Department of Agriculture gave as high as 21 per cent of crude protein before flowering. Digestion experiments have not been made, but the hay is readily eaten by horses, mules, and cattle, and seems to be relished by them. Bird Vetch (*Vicia cracca*).—Common in the borders of thickets from New England to the upper prairie region. The species is cultivated for fodder and is recommended for cultivation in wet meadows. In the shade it yields a return three times larger than in open places. Bitter Cassava (*Manihot utilissima*).—One of the best-known plants in tropical agriculture. There are thirty or more cultivated varieties of the bitter cassava in Brazil. The roots of some varieties are harmless; others contain the volatile prussic acid, a deadly poison. This is removed by heating or cooking. The yellowish roots do not boil soft like the reddish roots of *M. aipi*. The roots are often very large (2 to 3 feet long), weighing sometimes 100 pounds or more. Cassava is the source of tapioca, which is manufactured by heating the moist starch. It might well be introduced into Florida. Bitter Weed (*Senecio triangularis*).—Abundant in meadows and along streams in Oregon; sheep are very

fond of it. Black Grass (*Juncus gerardi*).—Common along the Atlantic, extending westward through the region of the Great Lakes; it is the principal constituent of the marsh hay cut along the coast, and is important as a forage plant which will grow where better species will not thrive. Black Medick (*Medicago lupulina*).—An annual or biennial, widely grown as a pasture plant in wet meadows and on stiff, clayey soils whch are too poor to grow alfalfa or clover; it remains green during the dryest summers; red-clover seed imported into this country sometimes consists of 50 per cent of *Medicago lupulina*. Blue Lupine (*Lupinus hirsutus*).—This lupine is an annual used for turning under as green manure. Blue-weed (*Hoffmanseggia stricta*).—A low perennial legume, common in the Southwest, often occurring as a weed in cultivated lands; the foliage is grazed by stock, and the underground tubers are eaten by hogs; it grows luxuriantly in semi-arid districts. Boerhavia (*Boerhavia erecta*).—This species, common in the mountains of New Mexico, is one of the best of the native pasture plants for sheep. Buckwheat (*Fàgopyrum esculentum*).—Buckwheat, a well-known annual, cultivated for its seeds, is a native of northern Asia, and has been under cultivation about one thousand years. It succeeds in cold climates on the poorest land. For fodder or as green manure, clayey soils produce the largest crops. On account of the short season in which it matures, it is adapted to cultivation in high latitudes and alpine regions. It is an excellent soiling crop, either fed alone or with oats or green corn, and is recommended for milch cows. Bud Brush (*Artemisia spinescens*).—A much branched perennial in the arid regions of Wyoming, Utah and other Western States; it develops early, being at its best by the end of May; it is said that sheep run hastily from clump to clump in search of this succulent morsel. Buffalo Clover (*Trifolium reflexum*).—A native annual or biennial species abundant in the middle prairie region where it furnishes a considerable amount of highly nutritious forage, greedily eaten by all kinds of stock. Bur Clover (*Medicago maculata*).—Widely introduced in the Eastern and Southern States as far west as Texas. Burnett (*Poterium sanguisorba*).—A so-called clover, belonging to the Rose family, only used in mixtures for sheep pastures on dry and barren sandy or calcareous fields; the hay contains about 15 per cent of crude protein. Bush Pea (*Thermopsis montana*).—A stout perennial herb, stems 2 or 3 feet high, native of the Rocky Mountains; the hay is readily eaten by stock if cut before the stems become woody. Bushy Dalea (*Dalea scoparia*).—A vetch with almost leafless stems; abundant on the mesas of New Mexico and Arizona, supplying forage during the dry season. Bushy Knotwood (*Polygonum ramosissimum*).—This is a native of the semi-arid plains and foothills from Texas to Idaho; bushy knotweed is closely grazed by cattle and sheep and supplies quite an amount of nutritious forage in summer and early autumn. Butterfly Pea (*Clitoria mariana*).—A low ascending or twining legume on dry hills and banks of streams in the Eastern and Southern States; a nutritious forage plant for woodland pastures. Butterweed or

Horseweed (*Erigeron canadensis*).—A bristly, hairy, erect, wand-like, annual with numerous heads of small, dirty white flowers, growing in waste lands and along roadsides; this has been reported valuable as sheep fodder in the arid regions of New Mexico and Arizona; horses like it.

Cabbage (*Brassica oleracea*).—An annual or biennial plant, indigenous to various parts of Europe and widely cultivated as a vegetable throughout the world. Cabbage is largely grown as a crop for soiling, and as a stable food in late autumn is far superior to turnips. It has been estimated that the crude protein of an acre of cabbage amounts to about 1,500 pounds. Where cabbages are grown as a commercial crop the waste leaves, trimmings, and heads that are under grade or fail to mature can be used to advantage in fattening sheep or young cattle. California Greasewood (*Allenrolfea occidentalis*).—The California greasewood occurs from northern Nevada and Utah to western Texas and southern California; like the common greasewood it is one of the characteristic black-alkali plants. It was found growing in the San Joaquin Valley on a heavy, yellowish clay soil containing from 27,320 to 194,760 pounds of total salts per acre-foot. This greasewood is grazed in winter and adds to the value of the pasturage at that season of the year. Camote del monte (*Peteria scoparia*).—A low, shrubby legume 2 to 3 feet high, rather abundant in the mountains west of the Pecos River; it has small, edible tubers which are eaten by hogs. Canadian Blue Field Pea (*Pisum arvense*).—There are many varieties of the field pea in cultivation, showing conclusively that it is one of the oldest forage plants, and yet it has not been brought to the attention of American farmers as largely as it deserves. In Canada the acreage is about the same as that of winter wheat. Much of the success of the Canadian farmers in fattening beef and pork for export is due to their extensive use of pea hay and oat hay and pea meal. The field pea is adapted to cultivation in the northern tier of States, from New England to Washington. It is sown in early spring at the proper time for seeding grain, using from 1 to 1½ bushels of peas and an equal quantity of either oats, wheat, or barley. The crop is ready to cut for hay when the dominant variety in the mixture is nearly ripe. If there are more peas than grain, then the yellowing of the pea vines and pods marks the proper time for cutting, or if the oats exceed the peas the mixture should be cut when the grains are in the dough stage. For a seed crop the peas are grown alone. They are not suitable for cultivation in the Middle or Southern States, because of the ravages of a vine mildew which affects the yield of forage and seed. It requires a long, cool season, with gradually increasing heat toward the time of maturity. According to average analyses, 100 pounds of Minnesota-grown pea hay contained 12.4 pounds of crude protein and 66.2 pounds of fat and carbohydrates. Of this, 7.6 pounds of protein and 41.5 pounds of the carbohydrates were digestible, giving a nutritive ratio of 1 to 5.7. One hundred pounds of the seeds contained 90.2 pounds of dry matter, of which 80.2 pounds were digestible, having a nu-

tritive ratio of about 1 to 3. The average of all American analyses shows a nutritive ratio for the seed of 1 to 2.8 and for pea meal of 1 to 3.2. This shows the peas to be a richer food than wheat bran, but less concentrated than the gluten, linseed, cotton-seed, and soy-bean meals. The field pea is an excellent soiling crop for late spring and early summer use, furnishing a large amount of succulent forage which is relished by cattle. It deserves wider cultivation by Northern farmers. Careless Weed (*Amaranthus palmeri*).—This has a wide distribution through the Southwest. Cattle are fond of the leaves and seeds; the amount of seed produced is enormous. Stockmen in New Mexico and Arizona have a high opinion of the careless weed; sheep may be fattened on the standing weed in winter when there is a shortage of feed on the open range. Carob bean, or St. John's Bread (*Ceratonia siliqua*).—A leguminous tree, often attaining a height of 50 feet, indigenous to the eastern Mediterranean region, but introduced somewhat widely through the Southern States and in California. Its saccharine pods are valuable as feed for stock. The pods are abundantly produced, even in arid regions and in seasons of drought. They contain about 66 per cent of carbohydrates, and are fed in rations of about 6 pounds per day, crushed or ground. Cassava (*Manihot aipi*).—A spurge, native of the Tropics, largely cultivated in the West Indies, Central and South America, and to a less extent in Florida and California. It is a rapid grower, with rank, branching, erect stems 4 or 5 feet high, large seven-parted, long-stalked leaves, and horizontal fleshy roots or tubers 3 to 5 feet long and from 1 to 2½ inches in diameter. It thrives in loose, dry, sandy loams, and produces from 6,000 to 8,000 pounds of roots per acre on soils of average fertility, and 10,000 to 20,000 pounds on fields that have received large amounts of fertilizers. The roots are fed whole or sliced, to all kinds of stock. They contain 72 per cent of starch, 17 per cent sugar and gum, and over 3 per cent of albuminoids. On account of the small amount of flesh formers contained in the roots, they should be fed with some nitrogenous food to make up the deficiency. Cassava is propagated by means of cuttings of the stems, each piece having two or three eyes or buds. These are planted in hills 4 feet apart each way, and the rows rolled, to pack the earth around the cuttings and prevent them drying out. The roots should be dug only as fast as they can be used, as they rot quickly when exposed to the air. Cassava is now extensively grown in Florida for the manufacture of starch. Cat's Paw (*Lamium amplexicaule*).—An annual of biennial common in waste places and fields from Texas to New England; in Texas it keeps green in winter and is eaten by all kinds of stock. Chestnut Sedge (*Cyperus erythrorhizas*).—An annual sedge with upright stems, leafy at the base, and with four or five leaves at the top; the flower-clusters are usually bright chestnut-brown; this plant furnishes good forage. Chick pea or gram (*Cicer arietinum*).—An annual, with many upright stems from the same root. The leaves resemble those of the vetch. The flowers are borne singly in the axils of the leaves on short stalks about one-half inch long. The pods are bladdery, in-

flated, from one-half to three-fourths of an inch long. Each pod contains one, or very rarely two, large seeds, which are wrinkled and bear a fanciful resemblance to a ram's horn, whence the Latin name *arietinum*. It is a valuable addition to the list of forage plants suitable to semiarid regions.

Comfrey (*Symphytum asperrimum*).—A coarse, rank-growing perennial herb, with purple flowers in nodding one-sided clusters, and large, rough leaves, widely introduced and recommended as a forage plant for rich soils. It has been claimed that an enormous quantity of forage may be cut from an acre, but after extended trials it is considered of less value than the clovers, and is now rarely grown. It is propagated from the roots, which are set in rows 18 inches apart, and 16 inches in the rows. Its cultivation is not recommended, except when it is desired to procure an enormous bulk of forage from a small amount of very rich land. Prickly comfrey has proved a success only in New York, Michigan, and Florida, in the latter State having been recommended as a good forage plant for waste, swampy lands. Cinquefoil or Five-finger (*Potentilla*).—There are a number of species native to the prairie regions which contribute some value to the native pastures; they belong to the Rose family and are closely related to the strawberry, which they resemble in foliage and habit of growth. Creeping Bush Clover (*Lespedeza procumbens*).—A slender prostrate plant, in dry, sandy soils throughout the Eastern United States, of value as a pasture plant. Creeping Kidney Bean (*Phaseolus diversifolius*).—An annual, with prostrate, spreading leafy stems, common on the prairies and cedar glades of the Southern States. The foliage is eaten by cattle and sheep.

Dakota Vetch (*Lotus americanus*).—The Dakota Vetch grows throughout the northern prairie region from Kansas to Montana, and is abundant on the Pacific Coast. Ranchmen in the Upper Missouri Valley consider the Dakota Vetch one of the best forage plants on the range. Where it is abundant, cattle are sure to get fat. It has been cultivated to some extent on plowed lands. Analyses of South Dakota grown hay, consisting entirely of this vetch, gave 17.6 pounds of crude protein in each hundredweight of hay. The per cent digestible has not been determined, but it is undoubtedly high, as cattle become "seal fat" where Dakota Vetch is abundant. The Dakota Vetch seeds freely in good seasons. In times of drought or shortage stock eat it down closely and prevent its ripening seed. Hence, the stand on the open range varies greatly, depending on the abundance or scarcity of other feed. Dandelion (*Taraxacum dens-leonis*).—A widely distributed weed; its leaves furnish a scant, but nutritious, early forage for sheep and the seed is therefore sometimes used in pasture mixtures. Deerwood (*Lotus glaber*).—This bush or weedy herb is a native of the mesas, mountains, and desert of southern California; it grows on the driest and most sterile soils, and is an excellent forage plant. Dogbane (*Apocynum cannabinum*).—This grows in the humid prairie region; although this is supposed to be poisonous, dogbane is eaten by cattle both in pasture and when it occurs in prairie hay. Dwarf Broom-weed (*Guteirrezia microce-*

phala).—A perennial of southern Texas, where it is of some value as a winter forage plant. Dwarf Rose (*Chamaerhodes erecta*).—A low herbaceous perennial 5 to 10 inches high, grows on the high plains from Colorado to Montana; cattle are fond of it. Dwarf Sedge (*Carex stenophylla*).—A low sedge, growing in moist prairies, valuable for the grazing which it affords in the early spring.

Elliott's Sida (*Sida elliottii*).—A low, shrubby or bushy mallow, which grows on hard, clayey soils and rocky land. It is an excellent pasture plant which readily catches from seed, provided the surface soil is scratched with a rake when the seed is scattered. Cattle, sheep, and hogs are fond of it, but horses and mules do not relish it. This sida has been quite widely introduced in the grazing regions of California. Endive (*Cichorium endivium*).—This culinary vegetable is particularly adapted as a pasture plant for extremely arid regions, as it matures seed which will germinate in the hottest deserts.

Ephedra (*Ephedra nevadensis*).—A leafless shrub with slender green branches; it grows throughout the Southwest and is generally found on the highlands and on rocky or gravelly soil; cattle eat it greedily. Earth or Peanut (*Arachis hypogea*).—An annual legume, native of Peru and Brazil, introduced very widely in cultivation throughout the Southern States. The peanut is hardy as far north as Maryland. This is one of the most valuable fodder plants for the Southern States. There are two varieties—the one which furnishes the peanut of commerce, which requires a long season; and the Spanish peanut, which matures in about three months. The pods of the latter are smaller, and the seeds fewer and smaller, than those of the edible variety. Peanut-vine hay is more nutritious than that of red clover. The yield of nuts ranges from 50 to 75 bushels to the acre. The Spanish peanut is the one usually grown for forage. The vines are pulled when the pods are about half formed, and are converted into hay by a method similar to that used in the treatment of cowpeas. The best commercial nuts yield from 42 to 50 per cent of oil. The cake, after the oil has been extracted, is rich in crude protein and has as high a feeding value as cotton-seed meal. Peanut cultivation has recently increased to a remarkable extent in India and on the west coast of Africa. In 1884 over 700,000 tons were exported from these countries to France for use in the manufacture of oil. On suitable soils the peanut is considered a very profitable crop, and its cultivation might well be extended in the Southern States. Everlasting Bean (*Phaseolus perennis*).—A species closely related to the garden bean, widely distributed in the Eastern and Southern States, and wherever found is eaten greedily by stock. Everlasting Pea (*Lathyrus polymorphus*).—A low pea, 6 to 12 inches high, with very large purple flowers, common on the prairies from Missouri and Nebraska. It furnishes considerable pasturage.

Fall Purslane (*Mollugo verticillata*).—An annual very abundant in southern New Mexico; fine forage for sheep and cattle; covers the ground like a carpet from September until frost. Fall Tallow weed (*Amblyolepis setigera*).—A leafy, rank-growing annual, with sweet-scented, bright-yellow flowers appearing in autumn on the

prairies of Texas and Mexico; cattle and sheep are fond of this plant and fatten quickly in pastures where it is plentiful. False Hellebore (*Veratrum viride*).—Rather common in the meadows in the Cascade range of Oregon; sheep are very fond of the young leaves and shoots when they first appear. Flat pea (*Lathyrus sylvestris wagneri*).—A perennial, which has of recent years been highly recommended as a forage plant on account of its drought-resisting qualities. The plant looks much like the ornamental sweet pea, with many weak, leafy stems which interlace in great tangled masses. The handsome rose-colored flowers are borne in loose clusters, and are followed by pods not unlike those of the field pea. Analyses of the hay, made at the Michigan Station, showed 27 per cent crude protein. The growth of the plant at first is slow and it is recommended to plant the seed in beds, from which they may be transplanted at the beginning of the second season to the place they are to occupy in the field. Several cuttings may be taken each season in favorable localities, and the average life of a field is from fifteen to twenty-five years. In this country the best results have been obtained with the flat pea in California, in the arid Southwest, and in the Southern States. The flat pea has now been grown experimentally in every State in the Union. As a rule the verdict in regard to it is that the flat pea is not as valuable as at first claimed. Fleshy Lupine (*Lupinus subcarnosus*).—A rather stout, silky perennial with palmately five-parted leaves and racemes of purple flowers. It grows in southern and western Texas, appearing early in spring, at which time both sheep and cattle graze it down. The seeds are ripened abundantly. The fleshy lupine or buffalo pea was formerly common, but has now about disappeared except where protected from stock. It is said to have been often cut for hay in the early days. A promising species for trial in cultivation. Fox Sedge (*Carex vulpinoidea*).—A perennial sedge, common to the western prairies; it grows in large bunches and prefers low prairies and rather dry swales; it is readily eaten by stock. Analysis shows that hay of this species contains over 10 per cent crude protein. Franseria (*Franseria dumosa*).—A shrubby plant related to the cocklebur, which is one of the most characteristic plants of the Colorado desert and the dry sandy plains of southern California. It is valuable feed for stock, either dry or green. It produces an abundance of burs, which are eaten by cattle and horses, and are as fattening as grain. It also makes a very fine feed for sheep. It dries up after the winter rains, but greens out after every shower.

Garden Pea (*Pisum sativum*).—The garden pea, so generally cultivated as an early spring vegetable, is equally valuable as a fodder crop, but it requires richer land and is more quickly affected by drought than the field variety. Some botanists regard this as a cultural variety of the field pea. Garry's Oak (*Quercus garryana*).—An oak growing on the slopes of Mount Hood in Oregon; sheep are extremely fond of the acorns, which are produced in great abundance. Giant Sedge (*Carex aristata*).—A perennial sedge forming a large part of the growth in moist, boggy places in the upper prairie region and supplying a large amount of early pasturage and hay. Giant

MOUNTAIN BUNCH GRASS.

Spurrey (*Spergula maxima*).—Similar to common spurrey, but making a ranker growth; it is rich in flesh-forming ingredients and is a valuable species. Giant Vetch (*Vicia gigantea*).—A tall perennial growing in the forest region of Oregon and Washington, highly valued there as a forage plant. Goat's Rue, also called Goat's Clover (*Galega officinalis*).—A forage plant of value on account of its resistance to drought, which has been recommended for the northern prairies and central Rocky Mountain districts; it is usually fed green, as it makes a poor quality of hay, and is not readily eaten by stock until they have become accustomed to its taste. Golden Clover (*Trifolium agrarium*).—A perennial widely naturalized on sandy fields and by roadsides in the Eastern States as far south as Virginia; it is of value in sandy pastures. Golden Rod (*Solidago*).—There are a great number of species distributed throughout the United States. In New York and other portions of the East where sheep are raised, golden rod is highly esteemed as a fattening, healthful, and nutritious forage, though cattle and horses will not touch it. Gorse (*Ulex europaeus*).—A perennial leguminous shrub, a forage plant for dry and barren hillsides, in places too steep or where the soil is too thin to admit of the cultivation of better ones. Farm horses almost entirely maintained upon it during the winter months, the crushed 2-year-old branches being fed at the rate of about 40 pounds per day. Twenty or 25 pounds of seed are required for an acre. It is a valuable forage plant to sow on barren hillsides. Sheep are very fond of and fatten quickly upon it. This legume is a strong potash feeder. Its roots penetrate deeply, bringing up stores of potash from the subsoil. On this account gorse is sometimes recommended as an excellent fertilizing crop to use in renovating hard and sterile soils. Greasewood (*Sarcobatus vermicularis*).—The name greasewood is commonly applied to a number of thorny shrubs characteristic of strongly alkaline soils. The common greasewood, or Chico plant, of the Rocky Mountain ranges from the Upper Missouri and Platte rivers to the Gila and the eastern slope of the Sierra Nevadas. It grows to the height of 4 to 8 feet. The narrow leaves are usually 1 to 1½ inches long, and are very numerous on the young shoots and branches. Many of the latter are thorn-pointed. One would never imagine that this greasewood could have any value as forage, yet cattle and sheep eat the leaves and browse the smaller stems. The seeds are also eaten. An analysis of the ash of this plant at the New Mexico Experiment Station showed 22 per cent of potash and 23.9 per cent of soda present. A sample of soil taken from under one of the plants contained two-tenths per cent of black alkali, while a similar sample taken 20 feet away from the plant showed no black alkali. Green Sage (*Bigelovia*).—There are a large number of species in the Rocky Mountain region; they are shrubby perennials with inconspicuous leaves and small yellow flowers. All are rank smelling and unsuited for forage in summer, but winter the green sages are eaten by both cattle and sheep. Ground almond or Chufa (*Cyperus esculentus*).—A perennial sedge, spreading extensively by underground stolons, which produce enormous numbers of edible tubers. In rich,

sandy loams it is often cultivated for hogs, which are turned into the field in autumn to root up the tubers. The tubers contain from 17 to 28 per cent of oil, 27 to 29 per cent of starch, and 12 to 21 per cent of gum and sugar. This sedge is an important forage plant for desert regions. Ground Nut (*Apios tuberosa*).—A wild climbing bean, with milky juice and straight or slightly curved many-seeded pods, growing in low grounds as far west as the Missouri River; it is eaten by all kinds of stock. The edible tubers which furnish food for swine, are borne on underground shoots. Ground Plum (*Astragalus crassicarpus*).—A prairie legume found throughout the Mississippi Valley. It has straggling fleshy stems, narrow leaflets and racemes of purple flowers, and produces every year an enormous number of succulent pods, whence the plant received its name. Sheep and cattle eat both the pods and leaves. In Texas, where the razor-back hog runs at large on the ranges, the ground plum is rapidly becoming extinct, and is only found in pastures protected by hog-proof fencing. The pods, or "plums," are sometimes used as a vegetable. The ground plum appears very early in spring, long before the clovers are ready to use, at a period when succulent food is needed for cows and young stock. Gunaninpil (*Allionia incarnata*).—A slender plant belonging to the Four O'Clock family, which comes up from the seed after the summer rains in the grazing region of Arizona and New Mexico and furnishes nutritious food for sheep and cattle.

Hairy Bush Clover (*Lespedeza polystachya*).—An upright wand-like plant growing on dry hills and barrens in the Eastern States, valuable as a pasture plant. Hall's Rush (*Scirpus hallii*).—A slender tufted sedge 6 inches to a foot high, growing on the borders of ponds from Texas to South Dakota; it is readily eaten by stock. Hairy Vetch (*Vicia villosa*).—This annual leguminous plant has been cultivated for about fifty years in some parts of Europe and was introduced into this country for the first time about 1847, under the name of Siberian vetch. It has been tried in various parts of the United States. Excellent reports as to its drought-resisting qualities and its adaptability to our climate have been received from Washington, Nebraska, Georgia, New Mexico, South Dakota, Minnesota, Montana, and Pennsylvania. Hairy vetch withstands winter cold and summer drought, but it does not do well where there is an excess of water in the soil. Hagy (*Lespedeza bicolor intermedia*).—A perennial with the habit of alfalfa, but more woody, grown at the North Carolina and Mississippi experiment Stations; it is considered to have some value as a pasture plant, especially for sheep. Halls' Rush (*Scirpus hallii*).—A slender tufted sedge, 6 inches to a foot high, growing on the borders of ponds from Texas to South Dakota. It is readily eaten by stock.

Hog peanut (*Amphicarpa monoica*).—A wild bean, native of the woodlands and forests throughout the region east of the Missouri River, with two kinds of flowers; conspicuous ones borne on the upper portions of the plant which seldom ripen seed, and inconspicuous fertile ones borne on slender stalks near the surface of the ground. The latter form fleshy subterranean pods, somewhat

like those of the peanut. It is eaten greedily by all kinds of stock, and adds materially to the value of woodland pastures. The underground fruits are eaten by hogs. Honey Locust (*Gleditschia triacanthus*).—A leguminous tree 30 to 60 feet high, native of the Eastern United States. The pods are eaten by stock, and the young growth is browsed by cattle.

Horse Bean (*Faba vulgaris*).—A coarse, erect, rank-growing annual of considerable value as a forage plant, grown in the Eastern States. The beans, which contain about 33 per cent of starch, are used for fattening cattle, but their use, if long continued without change or without proper admixture of other foods, often results in paralysis on account of the bitter poisonous alkaloids which the seeds contain.

Hop Clover (*Trifolium procumbens*).—In the Eastern and Southern States, this is common on sandy fields and roadsides, and furnishes scanty pasturage in early summer. Hottentot Fig (*Mesembryanthemum edule*).—A spreading plant with fleshy foliage, adapted to introduction as a forage plant in the Mohave and Colorado deserts and Africa. An authority says that a stretch of land covered with Mesembryanthemum is as good as a pond of water; these plants thrive along seacoasts and in the driest sandy deserts, withstanding extremely high temperature. Huajillo (*Pithecolobium brevifolium*).—A spiny leguminous shrub in the lower Rio Grande Valley; the persistent foliage is readily eaten by sheep and goats in the winter time. Hungarian Clover (*Melilotus linearis*).—A biennial sweet clover which succeeds in poor land, but especially on such as are fertile and humid, along streams and rivers; the quality of the forage is contested.

Jesuit's Tea (*Psoralea glandulosa*).—A trifoliate, bushy, leguminous shrub which grows in gullies and water courses which are dry in summer; it is eaten by cattle and horses and has been introduced into California as a forage plant for arid pastures. Jimsedge (*Carex jamesii*).—A sedge which is abundant in the moist meadows of northern Utah; it is pastured or mowed, and produces a fair quality of hay.

Lamb's Quarters (*Chenopodium*).—There are a large number in the United States, all of which are eaten by cattle and sheep, contributing much valuable forage when young. They are adapted to arid and barren lands, as well as to cultivated fields. Late-fruited Sedge (*Carex retrorsa*).—A tufted, leafy sedge, growing in boggy places in the lake region of Minnesota and the Dakotas; it is readily eaten by stock. Analyses show that it contains nearly 16 per cent crude protein. Lavatera (*Lavatera assurgentifolia*).—A shrubby, branching mallow 6 to 15 feet high and large rose-red and crimson flowers on long downwardly curving flower stalks. A native of the island off the coast of southern California; it has become established there on the sand dunes and along the seashore; the mucilaginous leaves are eaten by stock. Lentil (*Ervum lens*).—The leafy stalks of this annual legume make good forage; its seeds are palatable and nutritious as food for man and domestic

animals; it is suited for cultivation in cold climates and in the mountains at high elevations. Lesquerella (*Lesquerella gordoni*).—A yellow-flowered crucifer which appears early in spring and is much sought after by sheep on the Southwestern ranges. Lippia (*Lippia ligustrina*).—A spiny shrub 3 to 10 feet high; the leaves and twigs are eaten by cattle; it grows on rocky slopes in Texas. Long or Spanish Moss (*Tillandsia usneoides*).—An epiphyte belonging to the pineapple family, abundant in Florida and the Gulf States; cattle eat it greedily. In times of drought when there is a shortage of other food it is stripped from the trees and fed; besides being of value for forage, the moss is useful for a variety of purposes, notably as a fiber substitute for hair in stuffing mattresses and furniture. Long-stalked Clover (*Trifolium longipes*).—A native clover of the northern Rocky Mountains; sheep and cattle are very fond of it. Louisiana Vetch (*Vicia ludoviciana*).—A wild vetch occurring in the South; it is reported to have been successfully cultivated, showing it to be a promising native vetch. Low-land Clover (*Trifolium microcephalum*).—A wild species well liked by stock, common on lowlands in southern California. Lupine (*Lupinus laziflorus*).—A common and important sheep forage in the Cascade Mountains of Oregon.

Madder (*Rubia*).—The foliage of this prickly dye plant makes forage of fair quality if cut the second season, before the plants have commenced to blossom. Many-leafed Vetch (*Lathyrus polyphyllus*).—A robust vetch, common on the sands along the coast of Oregon; the pods and coarse forage are eaten by cattle. Meadow Rush (*Scirpus atrovirens*).—A sedge with rather stout triangular stems; widely distributed through the upper prairie and lake regions in wet, boggy meadows. It is readily eaten by stock. Mesquite Bean (*Prosopis juliflora*).—There are two well-known varieties of the small tree that produces this bean. The pods or beans are not only eaten by all classes of stock, but the Mexicans and Indians use them as a food. The pods are straight or curved. In one variety the bark of the tree is much rougher than in the other, and the bean is bright yellow when ripe and much sweeter to the taste, the color of the other being reddish rather than yellow. The mesquite bean is a thorny, leguminous shrub, growing in favored localities to a tree from 20 to 40 feet high, with a trunk sometimes reaching 2½ feet in diameter, but usually not more than 10 or 15 feet high. It is widely distributed from Texas to southern California, through tropical America to Argentina. The leaves are very good browsing for horses and cattle. It bears two or more crops of beans a year, which are equal to barley for fattening horses, cattle, sheep, and hogs. Metcalfe Bean (*Phaseolus retusus*).—In the Southwest there is a great variety of wild beans. They are scattered through every mountain canyon, on wooded slopes, and through the little parks along the streams. Formerly they were much more abundant, but are now relegated to cliffs and canyon walls, or to dry valleys, far from living water. Mexican Clover (*Richardsonia scabra*).—An annual which has been introduced into the Southern States and has now

spread along the Gulf westward into Texas. It is a succulent, creeping, prostrate plant, chiefly valued as a renovator of sandy fields on the coast. According to some it is a valuable pasture plant, while others affirm that neither cattle nor horses will eat it. On rich lands it can be cut, making a nutritious and palatable hay, which is readily eaten by all kinds of stock. Milk Pea (*Galactia volubilis.*)—A low plant with stems and leaves soft and downy; it is of some value as a summer forage in the Eastern United States. Miller Bean (*Galactia canescens*).—A perennial legume from the Mogollon Mountains in New Mexico. It has the vetch habit of growth, has been grown to a limited extent in cultivation, and is one of the most promising of the native arid-land forage plants. The yield of both seeds and foliage increases remarkably under favorable conditions, and the stout, woody root enables the plant to withstand the longest drought. Modiola (*Modiola decumbens*).—This is a prostrate, creeping, weedy, annual mallow, introduced into portions of California, and is recommended by the California Experiment Station as an alkali plant. Analyses made of it show that it contains almost as much crude protein as alfalfa. Sheep and cattle are fond of it, and eat it down closely. Because it roots freely at the joints, it is, like purslane, difficult to eradicate, and should be introduced with some caution. Montana Bush Pea (*Thermopsia montana*).—A stout perennial herb native of the Rocky Mountains. It is considered by some one of the best forage plants on the ranges, others claim that it is not relished by cattle, and may be poisonous; the hay is readily eaten by stock if cut before the stems become woody. Mountain Mahogany (*Cercocarpus betuleafolius*).—A small tree or shrub occurring in the southern Rocky Mountain regions; the twigs and leaves are browsed by cattle. Mountain Pea (*Themopsia millis*).—A perennial legume, native of the mountains of southern Virginia and North Carolina; it is readily eaten by stock. Mountain Red Clover (*Trifolium megacephalum*).—This wild clover grows in the mountains from Montana to California. It is distinguished from red clover in having unbranched stems about a foot high, and wedge-shaped five to seven-parted leaves which nearly all rise from the base of the stalks. The terminal flower head is about 1½ inches long. It is one of the best native pasture plants of the West. Myrtle-leafed Vetch (*Lathyrus myrtifolius*).—A vetch in western Oregon and Washington; the forage is eaten by cattle.

Narrow-fruited Sedge (*Carex sychnocephala*).—A slender, erect, perennial sedge growing in boggy places along streams and lakes in the Upper Missouri prairie region; it adds considerable value to the early pastures. Nelson's Saltbush (*Atriplex pabularis*).—A rapidly growing perennial which puts out a great many stems from the roots each year; it has only been collected in Wyoming on saline flats along the creeks and in the dry beds of alkali basins. Cattle and sheep relish the herbage. Nevada Clover (*Trifolium tridentatum*).—A wild clover, occurring in Nevada and Utah, which supplies palatable and nutritious forage in early summer, and is greedily eaten by cattle. The Western and Pacific coast States are very rich

in the number of wild clovers which occur there. California alone has more than sixty species. Northern Sweet-weed (*Hedysarum boreale*).—A tall and leafy plant with racemes of yellow flowers; it is found in open woodlands in the northern Rocky Mountains; cattle are said to be quite fond of the forage. Nuttall's Salt Sage (*Atriplex nuttallii*).—Nuttall's salt sage is the most common salt sage of the plains of northern Colorado, Wyoming, Montana, and northern Nevada, and is considered by stockmen the most valuable of that region. It is a low, leafy shrub seldom more than 2 or 3 feet high, and, like the shad scale, is perennial. It grows where the soil is dry and so strongly impregnated with alkali that little else will thrive except rabbit brush and bitter sages. It is one of the best of the wild forage plants for winter pasturage. Nelson states that the leaves and young twigs, and especially the seeds, are very fattening, and that sheep eat the forage both green and when it has cured upon the ground. The plant endures much severe trampling and hard usage.

Old-man Saltbush (*Rhagodia parabolica*).—A low, spreading, perennial shrub, seldom growing more than 3 to 5 feet high. Its leaves and branches are whitish. Cattle and sheep graze this plant wherever found and is said to be one of the most drought resistant of all the saltbushes. It will stand some frost, and would be a good plant to introduce on the cattle ranges of Texas and New Mexico. Like all others of this group, it not only produces an abundance of seed, but may readily be reproduced from cuttings. One-flowered Vetch (*Vicia monantha*).—An annual vetch which supplies forage of good quality on poor, sandy, or granitic soils; the seeds are eaten like lentils; it is a good winter crop for the South. Oregon Vetch (*Lathyrus oregonensis*).—This and a number of other species grow in fire glades in the lodgepole pine forests of Oregon; all are readily eaten by sheep and are excellent fatteners.

Peppergrass (*Lepidium lasiocarpum*).—An annual weed with hairy stems and rough finely-cut leaves, occurring in the arid Southwest; sheep are very fond of it. Pigweed (*Amaranthus retroflexus*).—This annual weed is common in gardens and cornfields in the West. Sheep and cattle relish it, and it often makes valuable feed in midsummer when pastures are dried up, or in the cornfields after the fodder has been cut and the corn husked. It is quite resistant to both alkali and drought. While it is often a decided nuisance in cultivated land, this plant is esteemed a good forage plant by stockmen wherever it occurs on the ranges. It is becoming a common practice in the prairie States to run sheep in the cornfields from about the time the grain is in the milk and the corn and the corn has grown to its full height. The sheep clean out the pigweed, purslane, and weedy grasses, and browse the fallen corn blades. The weeds of the cornfields thus supply succulent forage at a time when pastures are dead and brown. Pine Grass (*Carex pennsylvanica*).—A perennial, turf-forming sedge in the lodge-pole pine forests of Oregon, and wooded areas eastward to the Atlantic; it supplies some grazing for sheep when it first comes up in spring. Prairie

Clover (*Kuhnistera*).—A number of species of prairie clover are common throughout the prairie region and westward into the Rocky Mountains; they are eaten by sheep and cattle green or as part of the prairie hay. Prairie Sagebrush (*Artemisia ludoviciana*).—A low perennial with lanceolate wooly leaves; it grows on the western plains from Montana and Minnesota to Mexico; though bitter, the foliage seems to be nutritious and cattle are fond of it. Prairie Turnip (*Psoralea esculenta*).—A perennial legume common in the prairie region. It produces edible tubers. Formerly used as food by the Indians and voyageurs, and probably of some value as food for hogs. Prickly Pear (*Opuntia engelmanni*).—A species of flat-jointed cactus common in central and southern Texas. The stems are mucilaginous and watery, and in times of drought serve to some extent as food, or, more especially, as water. Cattle and sheep may be kept alive for several months on prickly pear alone. Where the stockman makes no provision for bad seasons, prickly pear is evidently a good thing. Viewed from this standpoint the prickly pear is not a success. It spreads very rapidly, forming dense thickets, encumbering the land and driving out the best grasses. Cattle do not eat it, except the ripe fruits, as long as there is anything else to satisfy their wants. It is only valuable as an emergency ration. Before feeding, the spines must be destroyed either by burning or boiling. Cattle die in great numbers in southern Arizona during times of drought as a direct result of feeding on cactus. The spines pierce their mouths and work through the walls of the stomach and intestines, even penetrating the muscles and eventually causing the death of the animal. It is a common sight in the cactus-infested pastures of southern Texas to see cattle with their flanks looking like pincushions, thickly covered with the long yellow spines of the prickly pear. There are many more desirable forage plants than this cactus, and it is probably on the whole more of a curse than a blessing. Pride of California (*Lathyrus splendens*).—This vine has been introduced into gardens because of its beautiful flowers. It grows wild in the mountains of southern California, and is said to be an excellent forage plant. Purple Bush Clover (*Lespedeza violacea*).—A bush clover with upright or spreading branching stems, common in the Eastern United States, and contributing a small amount of forage in woodland pastures. Purple Clover (*Trifolium involucratum*).—An annual with leafy, branching stems, terminating in from one to three purplish heads; it has a wide range throughout the West; cattle and sheep are fond of it. Purslane (*Portulaca oleracea*).—This well-known weed is of considerable value as an autumn forage plant in the South and Southwest. The fleshy leaves and stems are put forth in great abundance during the hottest and driest weather, and it is hard to kill. Fed to cows it increases the flow of milk, but acts as a laxative if too much is given at once.

Ramie (*Boehmeria nivea*).—This well-known fiber plant, which has been introduced rather widely throughout the United States in the last twenty years, furnishes a large amount of forage of fair quality. It is eaten well by all kinds of stock; so that wher-

ever this plant is grown for its fiber it is well to remember that it will also furnish valuable feed. Rape (*Brassica napus*).—Rape has received but little attention in America until within comparatively recent years, and is now much more widely grown in Canada than in the United States. Practically, all the rape grown in this country is the winter or biennial sort, but in Europe, especially in England, summer rape is widely cultivated. The seed yields about 33 per cent of expressed oil, which is of value for lubricating and is also used for lighting. The compressed rape-seed cake is used as a food for stock and as a fertilizer. It is regarded as particularly valuable as a fertilizer for flax and turnips. The seed is much used as a bird food. In this country rape is grown almost exclusively for forage, being used chiefly for soiling and summer and autumn pasturage. Dwarf Essex or English rape has been most widely cultivated. Recently a variety has been placed on the market under the name of Dwarf Victoria rape, or simply Victoria rape, which has given excellent results in New England, and also in the Northwest, yielding, as a rule, rather better than the Dwarf Essex. At the New Hampshire Experiment Station this variety is reported as yielding nearly 50 tons of green fodder per acre, and yields of 25 to 30 tons per acre are reported from South Dakota and elsewhere in the Northwest. Under average conditions a yield of from 10 to 20 tons or more may be expected from either of these varieties. Throughout the Northern States generally, seeding may take place from the 1st of June or possibly earlier, to the middle or last of July, according to the season and locality. In the South the seed may be sown in September or early in October. Under favorable conditions 3 pounds of seed per acre will be sufficient, and it will never be necessary to use more than 5 pounds per acre. The seed should be planted in drills far enough apart to allow cultivation. In practice the distance varies from 24 to 28 inches. For planting large fields a grain drill with some of the feed hoppers closed may be used. When the ground is clean and in proper condition, good results may be obtained by using the grain drill with all feed hoppers open, and giving no after cultivation. As a rule, however, it will be best to plant in wide drills and give sufficient shallow cultivation to aerate the soil and destroy weeds. With favorable conditions, good crops of rape may be obtained from broadcast seeding; but whenever there is any danger of the surface soil becoming very dry during the time the seed is germinating, or when land is at all foul, drilling will give much better results. The rape is usually ready for use in about eight or ten weeks from the date of seeding. The general practice is to use it as a soiling crop or as pasturage. Sheep and swine may be turned into the field and allowed to remain until the rape is pastured off. Cattle may also be allowed to run in the field, but as they waste much of the forage by pulling up the plants or trampling them down it is a better plan to cut the rape with a scythe or mower and feed it green. With sheep and cattle care should be taken at first not to allow the animals to eat too much, as there is danger of injury from bloating. Hungry animals should not be allowed to eat their fill,

and it is not best to turn them into the rape when the leaves are wet. There is no danger of bloating with swine. It is an excellent plan to have the fields so arranged that the sheep and cattle have access to an open pasture as well as to the rape. Animals should have free access to salt at all times when being pastured on this crop. Rape has a high feeding value. It makes an excellent feed for fattening sheep and swine and for producing an abundant flow of milk in milch cows. On account of the great danger of tainting the milk many people do not usually feed it to the cows until after milking. Rape can be used to good advantage as a part of the ration for animals that are being fed in pens for market or for the show ring. It is also a valuable food for young lambs at weaning time. By beginning as early as practicable in the spring and seeding at intervals of two or three weeks, a continuous succession of rape can be produced throughout the period when the permanent pastures are most likely to be short. Rape will endure quite severe cold weather and thus will last a long time after the ordinary pasture grasses succumb to the frost. By the use of this crop stock can be gotten into good condition for the holiday markets or for winter, and there need be no check in growth, fat, and milk production through insufficient succulent food during the last summer and autumn months, as is too frequently the case. Under favorable conditions two or three cuttings may be made in a single season from a field of rape grown as a primary crop. Not much attention has been paid to growing rape for seed in this country, possibly because of the fact that in most localities where this crop has been extensively grown the winters are so severe as to destroy the plants. It seems, however, that there are localities where rape can be profitably grown for seed, and farmers might well devote more attention to this feature of rape growing. Ragweed (*Ambrosia artemisæfolia.*)—This pernicious weed of old fields and waysides has some value as a forage plant; it is sometimes cut for hay in Virginia. While stock do not graze the plant, horses eat ragweed hay with great relish and apparently do well on it. River Club-rush (*Scirpus fluviatilis*).—A stout, erect perennial sedge, common on the borders of lakes and large streams from New England west to the Dakotas and Iowa, and, because of its abundance, is valuable for early feed. Round-headed Bush Clover (*Lespedeza capitata*).—A bush clover common in dry and sandy soil from New England to Florida and westward to the Prairies; it is a good pasture plant. Rattlers (*Crotalaria lupulina*).—An annual legume with short, bladder pods in which the seeds rattle freely when ripe. It grows in New Mexico and Arizona. Although it is said to have some value as forage, it should be looked upon with suspicion because of its close relationship to the Rattle-pod pea, one of the worst of the poisonous loco weeds of the humid prairies. Round-leaf Saltbush (*Atriplex nummularia*).—A perennial shrub, 6 to 10 feet high; the leaves and stems are covered with whitish down, and the broad, fleshy leaves are produced in great abundance. In habit of growth and appearance it resembles the native shad scale of the Rocky Mountain region. It is only adapted

to cultivation in the warmest portions of the Southwest and might well be grown more extensively in southern California and Arizona. If rooted cuttings are planted over the range immediately following heavy rains, when the soil is wet enough to fairly start the plants, it will undoubtedly become a valuable addition to the range forage. This saltbush produces a great amount of seed in the driest seasons, resembling in this characteristic most native desert plants. The seeds germinate readily when sown on moist soils. Rusby's Sedge (*Cyperus rusbyi*).—A perennial sedge of southern New Mexico and Arizona. Very slender, but yielding a considerable amount of large and heavy seed; this sedge was formerly very abundant, but it is now mostly to be found only in the upper canyons where inaccessible to cattle. All kinds of stock are fond of the ripe seeds.

Sainfoin (*Onobrychis sativa*).—A deep-rooting, perennial legume, extensively cultivated in the temperate portions of Europe on dry, calcareous soils which are too barren for clover or alfalfa. The stems are erect or ascending, 1 to 2 feet high, ribbed and downy, the leaves unequally pinnate, composed of 6 to 12 pairs of opposite leaflets, with an odd terminal one. A permeable, well-drained subsoil is essential for its growth. Like alfalfa, it is quickly killed whenever the ground becomes saturated with water, and is therefore not suited for growth in wet meadows or in marshy lands. There is no better plant for growing on barren hills, but it does better on the sunny slopes than on those facing north. It is rather difficult to establish, as the plants are easily killed when young, but when once well rooted, sainfoin will live from twenty to twenty-five or sometimes a hundred years, provided the soil is rich enough. One crop of hay can be cut each year. It should be cut at the time of full bloom. Saleratus Weed (*Salicornia herbacea*).—A low, fleshy, leafless herbaceous plant, growing in the borders of salt marshes from Arizona to the Saskatchewan, and along the Atlantic coast. It occurs on soils too salty or too alkaline to support any other plant. In portions of the Southwest it is valued highly for winter feed. After frost stock live almost entirely upon saleratus weed, winter fat, sagebrush, green sage, and the native salt-bushes, depending more on these than on the grasses. Sand Spurrey (*Spergula arvensis*).—An annual, producing a low, tangled mass of succulent stems with numerous whorled linear leaves. It produces a crop in eight or ten weeks, and is valuable as a catch crop in short seasons, and for soiling sheep and milch cows. Serradella (*Ornithopus sativus*).—An annual legume, which is valuable as a fodder plant on moist and sandy sterile soils. At the Pennsylvania Station the yield from two cuttings was 11½ tons of green forage. It does not require lime, and is often used as a green manure to bring up the value of sterile fields. The forage, which is much relished by cattle and sheep, has about the same feeding value as red clover, but the yield is usually much less. Scouring Rush (*Equisetum laevigatum*).—The most common scouring rush of the prairies and Rocky Mountain region; the plants are less harsh than the Eastern forms; when young, the stems are greedily eaten by cattle and horses. Seaside Arrow-grass (*Triglochin*

maritimum).—A marsh plant common along the Atlantic coast and westward across the continent in saline, marshy, and boggy places. It is eaten by cattle and adds value to the native herbage of wet pastures. Sedge (*Fimbristylis laxa*).—Leafy perennials growing in low wet meadows in the South. Cattle do not fatten on lowland pastures, but make good "feeders" and "stockers" for topping off with corn or cotton-seed meal. Sheep-lick (*Guillemina illecebroides*).—A prostrate, matted annual with minute leaves which are bright green above and cottony beneath. Very common on the ranges in New Mexico and Chihuahua. It is related to the tumbleweeds. Sheep lick it up like salt. Shepherd's Purslane (*Androsace occidentalis*).—This low annual, only 1 or 2 inches high, grows abundantly on the ranges in the southwest. At the base there is a thick rosette of short leaves that lie flat on the ground. Each root sends up 10 to 20 short flower stalks bearing umbrels of small flowers. Shepherd's purslane comes up through the snow early in March. Sheep eat it as eagerly as they would salt, and fatten where it is at all abundant. The ground is often covered with a close mat of the green leaves. Although the quantity of forage is comparatively insignificant, this plant is highly prized by sheepmen on account of its earliness and abundance. Shoe-string (*Psoralea melilotoides*).—This and other species occur on dry pasture lands in the Southern States, and are said to be eaten by all kinds of stock. There are about a dozen species native to the prairie region, which add value to both pasturage and hay. Because of their tough, slender roots they are commonly known as "shoe-strings." Silvery Sage (*Artemisia cana*).—A small shrub, 2 to 3 feet high, with slender branches and long, entire leaves, grayish-white in color. Of the sagebrushes this is the best forage plant. In quality it probably does not differ materially from common sagebrush, but in proportion to area occupied it produces much more forage. It is found chiefly in the alluvial soil on the banks of streams on the foothills and high plains of the West. Its forage value is due to the production each year of a very large number of long, slender, tender shoots, which are browsed in winter. Smooth Milk Pea (*Galactia regularis*).—A low, prostrate or twining, perennial bean with nearly smooth stems, trifoliate leaves, and purple flowers in interrupted or nodding racemes. Common in sandy woods from New York to Florida and Mississippi. It makes an excellent summer forage for milch cows, and adds value to woodland pastures.

Southern Clover (*Trifolium amphianthum*).—A low, slender stoloniferous clover, occurring in Louisiana and Texas upon the most sterile soils. It spreads rapidly and reseeds itself freely, producing a large amount of early pasturage. It begins to blossom about the middle of May. It is one of our most promising native clovers.

Sotol (*Dasylirion texanum*).—A rich fodder plant of the lily family, which occurs throughout western Texas and northern Mexico. It grows abundantly in the great bend of the Rio Grande and west of the Pecos and is highly esteemed, producing fodder for sheep in the winter season and during periods of extreme drought. The

appearance of the plant is something like that of a large pineapple, growing on a trunk 2 to 5 feet high. The portion eaten is the inner cabbage-like heart, which remains after the spiny leaves have been cut off. An analysis of this shows that it contains about 12 per cent of sugar and gum and about 3 per cent of crude protein, besides 65 per cent of water. No attempt has been made to cultivate sotol, and it is becoming exterminated in many portions of its range. Sheep can exist upon it four or five months in the winter without access to water, so that it would be an excellent forage plant for dissemination and cultivation in arid regions where the winters are not too severe.

Spiny Salt Sage (*Atriplex confertifolia*).—A perennial, spreading shrub, with numerous short, thick leaves and spiny branches. It grows 2 or 3 feet high in clumps 4 to 6 or 8 feet in diameter. The leaves and fruits drop off in autumn and are collected in the depressions of the surface or form little wind drifts behind the bushes. These piles of leaves and seeds are the first to be eaten by the sheep and cattle when they enter the winter pastures. The spiny branches are also browsed to the ground. This salt sage is apparently more resistant to strong alkali than almost any of the others, as it often occurs on "greasewood lands" containing a large amount of sal soda. It grows from the Dakotas, Montana, and Idaho southward to Mexico.

Spring Vetch (*Vicia sativa*).—This has been tried in nearly all the States and has proved very unsatisfactory, except for certain districts in New England, New York, northern Michigan, Wisconsin, and lower Canada. Showy Vetch (*Lathyrus ornatus*).—This is common in Nebraka and westward; the green pods and peas are used as a vegetable and the plant is grazed by cattle. Slender Bog Rush (*Juncus tenuis*)—A slender, tufted, wiry rush, 6 to 18 inches high, with leaves about 6 inches long; common in the prairie region. Though rather tough and wiry, it is readily eaten by stock. Small flowered Vetch (*Vicia micrantha*).—A smooth vetch with four to six linear obtuse leaflets, common in the South; it is eaten by cattle and should be grown under improved conditions. Sneezeweed (*Helenium tenuifolium*)—A very common woody plant in Southern pastures and old fields. It is readily eaten by stock, but can hardly be called a forage plant because it makes milk bitter. Spiny Sida (*Sida spinosa*)—A weed of the Mallow family in the Southern States. It has been recommended as a good crop for renewing worn lands and makes very fair winter grazing for cattle. Spurred Butterfly Pea (*Centrosema virginianum*)—A twining perennial bean with trifoliate leaves and large, showy violet flowers an inch long; the pods are 4 to 5 inches long, many-seeded, and marked with a raised line on each side next the margin. Common in sandy woods in the United States. Spurrey (*Spergula arvensis*).—An annual, producing a low, tangled mass of succulent stems with numerous whorled linear leaves. It produces a crop in eight or ten weeks, and is valuable as a catch crop in short seasons, and for soiling sheep and milch cows. It has been especially recommended as a first crop

on the pine barrens of Michigan, to turn under for green manure. The air-dried hay contains about 12 per cent of crude protein. Spurrey has recently been rather highly recommended for sowing on the ranges in southern California. It is quite drought resistant and ripens seed very freely, so that if once widely scattered it would probably maintain a foothold for a good many years. It may, in part, fill a like want on the Texas ranges, and deserves a trial to determine whether it will hold its own as well on the uncultivated sod lands as in fields. In the East spurrey is rather common as a weed in fields and gardens. Square-pod Pea (*Lotus tetragonolobus*)—A much-branched ascending annual, closely related to the birdsfoot clover. It is a native of southern Europe, and is there grown for salads and as an ornamental plant. It has been recommended by the California Experiment Station as one of the best winter crops for plowing under in spring as green manure. It yields from 20 to 25 tons of green fodder, equivalent to 4 or 5 tons of air-dried hay, and the roots are described as being fairly incrusted with nitrogen tubercles. The plant does not contain as high a percentage of crude protein as alfalfa or the clovers, but it is worth two or three times as much as either as a green manure because of the enormous amount of herbage produced. Sown in January, it will be ready to be plowed under in May. The seed should be thinly broadcasted on freshly plowed land and harrowed in. Star Thistle (*Centaurea americiana*)—This rather common weedy thistle, while considered a pest in eastern fields, has much value as a forage plant in semi-arid regions. The young plants are eaten by stock and are apparently nutritious, as cattle pastured in old fields covered with star thistles fatten rapidly. It is said to increase the flow of milk when fed to cows. Stickseed (*Echinospermum redowshii*)—This and other perennial borages are plentiful in the Rocky Mountain region. Sheep are fond of them; they supply a goodly amount of forage in early spring. Stolley Vetch (*Vicia leavenworthi*)—An early pasture plant from central Texas, which grows wild on the granite soils and red prairies. This vetch has the same habit and much the appearance of the hairy vetch. It branches from the base, the weak, trailing vines being 2 to 3½ feet long. As many as fifty or sixty stems and branches have been observed from a single root. It has a somewhat local distribution, occurring in central and western Texas. It grows in the creek bottoms and among the underbrush along streams, and where protected from destruction by cattle spreads to the open prairies. Stork's Bill (*Geranium carolinianum*)—An annual in western Washington and Oregon on poor land; during the cooler parts of the year it is often quite plentiful and is an excellent pasture plant. Straw Sedge (*Carex straminea*)—A perennnial sedge, with erect, slender, clustered stems, common in the Mississippi Valley. It contributes a large amount of forage in the localities where it is common. Sulla (*Hedysarum coronarium*)—This perennial legume is a native of southern Italy, and was first introduced into cultivation in 1766. It grows best on sandy or clayey soils which are well drained, or where the ground water is not less than 6 to 10 feet below the surface.

It will withstand slight frosts, but is killed if the roots are frozen. It has been introduced into this country for trial in Florida and the Gulf States. The practice is to sow the seeds in September or October, on land that has been deeply plowed and thoroughly pulverized, either alone or with winter oats or wheat. After the latter has been taken off the field, a crop of sulla 4 to 6 feet high springs up and is ready to cut from the latter part of May to July. In feeding value it compares very favorably with alfalfa, and is better adapted to tropical or subtropical climates, provided seed is sown on well-drained and well-prepared land. If the seed bed is only given a shallow cultivation in preparation for sowing, it will require a full year before one crop can be taken from the land. The same precautions are necessary in using sulla as a soiling crop as with clover and alfalfa, to prevent loss of cattle through bloating. Sulla has not proved so successful as alfalfa in the South. Sulphur Vetch (*Lathyrus sulphureus*)—A perennial vetch much resembling the flat pea, but more leafy; rather common east of the mountains in Washington and Oregon. A very useful species; the forage is eaten by cattle. Sunflower (*Helianthus annuus*)—The sunflower is a well-known annual weed, which has become widely spread throughout the United States; its leaves and heads make good green fodder for cattle and horses, and its oily seeds, which are produced at the rate of from 20 to 50 bushels to the acre, furnish an oil cake which is a valuable stable food. Swamp Horn Clover (*Lotus uliginosus*)—This is a slender, branching clover with heads of rather large, yellow flowers and slender, elongated pods. It is now cultivated in Wisconsin and Minnesota on sour, peaty, or muck soils. Sweet Clover (*Melilotus alba*)—This is a weedy biennial, concerning which extravagant claims have been made. It is chiefly valuable in the Southern States for early pasturage and for green manure. The long taproots descend deeply into the soil, and when the crop is turned under, a very large amount of available plant food is left for the benefit of succeeding crops. Because of its strong odor, stock will not eat it until they have acquired the taste, but if they are turned into a field of sweet clover in early spring, before the other clovers have commenced to come up, they will quickly learn to eat it. The seed should be sown alone in August, or in February, at the rate of half a bushel to the acre. If sown in spring, a crop may be cut in autumn, and two or three crops the second season. It ought never be allowed to go to seed. Sweet clover is a good green manuring crop to use in bringing up the value of old fields and barren or washed surfaces where a large bulk of nitrogenous organic matter is desired. Sweet Potato (*Convolvulus edulis*).—The fleshy roots are used in many parts of the Southern States as feed for cattle, and the vines are cured on racks like cowpeas and used for hay.

Tallow Weed (*Actinella linearifolia*)—An annual or biennial wild tansy, occuring in the southern prairie region from central Texas to New Mexico. Valuable for early spring grazing on the ranges. The basal rosette of strap-shaped leaves appears long before the native grasses commence to grow. The bright yellow flowers

borne on erect stems 4 to 12 inches high appear from February to April, according to the season, at a time when there is no other green feed, and the whole plant is greedily eaten by cattle and sheep. It is said that there is no other arid-land plant which will put so much fat on a sheep's kidneys in so short a time. Tallow weed deserves a thorough trial in cultivation. Tarweed (*Madia sativa*)—A rank-growing annual, native to both Chile and California, which has been recommended as an excellent summer forage for sheep. The leaves are clammy with viscid exudation, and the plant has a rank odor. Its chief merit is its rapid growth. It has been cultivated in the arid Southwest and California. An excellent lubricating oil is extracted from the seeds. Ten-finger (*Lupinus rivularis*)—A common lupine in the Cascade Moutains of Oregon. The forage is eagerly eaten by sheep. Texas Beggarweed (*Desmodium paniculatum*)—A tall, slender leafy legume, native in west Texas. It makes an excellent quality of feed for stock, and when growing thick enough to mow is convertible into first-class hay. It thrives best on low, moist soils, but occurs also on the drier uplands. It resembles the Florida Beggarweed in general appearance and ought to be tried in cultivation to find out whether it would do as well in the semi-arid Southwest as that plant does in Florida. Texas Pea (*Astragalus nuttallianus*)—A perennial, like the ground plum in habit and general appearance, but with narrow, curved, bladdery seed-pods on an upright stem. It is abundant in central and northern Texas, preferring the drier ridges and stony hills, while the ground plum grows best in moister valley lands. It is much relished by cattle and is disappearing wherever the ranges have been overstocked. It grows well on cultivated land, increasing in height and amount of seed produced, thus indicating adaptability to improved conditions. The seeds ripen about the 1st of May, after which the leaves and stems die down and, becoming brittle, are broken to pieces and blown away. On the ranges the Texas pea supplies a large amount of highly nitrogenous forage in early spring, when such feed is most needed. Tsama Melon (*Citrullus vulgaris*)—A wild watermelon from the Kalahari Desert in South Africa. There are two kinds native to this great waterless desert—one with bitter fruits, the other with sweet watery ones. Seeds of the latter were secured by the Department of Agriculture and were cultivated in 1898 at the Arizona Experiment Station with a view to securing seeds for a more general distribution. The Tsama melons are round, about 4 inches in diameter, and are produced in the greatest abundance. In the Kalahari Desert they form at times the only source of water for travelers crossing this great "Thirstland," and the herds of antelope that roam these wastes subsist upon them. They are especially adapted to withstand great extremes of temperature and drought, and hence would be valuable for wide introduction through the deserts of Arizona and southern California. Although small, the fruits supply both food and drink for stock and the passing traveler. Tumble or Rolling Pigweed (*Amaranthus blitoides*)—A spreading, branching annual which comes up on newly broken ground, and with other weedy species is readily eaten

by cattle before it has become woody. Because of the tumbling of the plants in autumn when they are broken off at the surface of the ground, the seeds are widely scattered by the winds. Tumbling Salt Sage (*Atriplex volutans*)—A rank, leafy annual, which forms an upright compact mass 2 or 3 feet high. Nelson says that it may prove more valuable for certain alkali soils than any of the foreign species. It produces an abundance of seeds. Tumbling salt sage gets its name from the fact that, like a great many other plants native to the Western plains and prairies, the stem breaks off close above the ground in autumn, and the plant goes rolling across the country, scattering its seeds at every bound. It might prove a bad weed in grain fields because of this tumbling habit. It has very little forage value after the seeds have fallen. Tufted Spikerush (*Eleocharis obtusa*)—A tufted annual spikerush grows in shallow ponds and marshes in the Upper Missouri region, supplying a fair quality of forage in localities too wet for grasses and sedges. Tule (*Cyperus strigosus*)—A tall sedge growing in marshy places in California and Arizona. It is much relished when young by all kinds of stock.

Upright Knot Tanweed (*Polygonum emersum*).—This is well regarded as a forage plant for wet meadows and marshy places. It is abundant throughout the United States, and is one of the species which would not become a weed if brought under cultivation. Cattle are very fond of it. There are numerous other species of knotweed which in the localities where they grow add materially to the value of pasturage. Upright Sedge (*Carex stricta*)—A slender, tufted, perennial sedge, forming large bunches, common in low, wet meadows and along the margins of ponds and lakes throughout the prairie region. The hay contains 11 per cent of crude protein. Utah Saltbush (*Atriplex truncata*)—Utah saltbush is one of the best of the annual species. It is common in northern Utah and Nevada and eastern Oregon on clayey soils impregnated with common salt and white alkali. A few seeds were distributed in 1896 by the Division of Agrostology, and a number of those who grew it have reported it as being of much promise for the reclamation of alkali soils. It is closely grazed by cattle wherever they have access to it, so that it is hard to find in sufficient amount to supply any quantity of seed. It is never abundant except where undergrazed or protected by fences.

Water Grass (*Carex muricata*)—A sedge, native of Arizona and New Mexico; very abundant in low places on the mesas. It contributes a large part of the hay cut from wet meadows, and is relished by stock. Winter Fat (*Eurotia lanata*)—A white-hairy perennial, 1 to 2 feet high, closely related to the saltbushes, and growing with them on strongly alkaline soils. The cottony seeds are produced in great abundance, and both seeds and stems are eaten greedily by all grazing animals, so that this plant is now almost exterminated wherever cattle have free range. It is widely distributed from Manitoba to Texas and westward to the Sierra Nevadas, and wherever it occurs is highly spoken of as a winter forage plant. Winter Purslane (*Veronica peregrina*)—This insignificant annual appears in such

VICTOR ROSELLE.

(See page 592.)

abundance on the ranges just after the melting of the winter snows that it becomes quite important as a forage plant. Wood Rush (*Juncoides parviflorus*)—A grass-like, leafy rush, quite abundant on the lower mountain slopes and even above timber line in Colorado and the adjoining States. Cattle and sheep eat it readily. Woodland Pea (*Lathyrus venosus*)—A perennial woodland vetch quite common in the Eastern States. Cattle are fond of the plant; it is one of the most valuable of the woodland legumes. Woolly-joint (*Eriogonum brevicaule*)—A yellow-flowered perennial from the Red Desert of Wyoming. Prof. Aven Nelson says that it is grazed by cattle in summer in preference to other feed. There are about 200 species of Eriogonum, mostly Western; all have value as forage plants where they occur abundantly. Wooly Plantain (*Plantago gnaphaloides*)—A low annual with rosettes of silky narrow leaves. It is one of the earliest plants to start in spring, and supplies some little grazing at that time. Later it gets dry, and is not eaten. It is very common on the prairies west of the Mississippi River. Woolly Saltbush (*Enchylæna tomentosa*)—An erect, sprangled saltbush with hairy stems and fine leaves. This Australian saltbush has been cultivated in the grass garden at Washington, D. C. Apparently a good species for introduction in the Southwest.

Xanthisma (*Xanthisma texana*)—A virgately branching perennial weed 1 to 3 feet high. Grows in Texas in fields and waste places and in stony pastures. The yellow flowers and seed heads are cropped off by cows and mules. They do not touch other parts of the plant. The flow of milk is said to increase during the time when this weed is in flower because of the cows eating the nutritious oily seeds.

Yam Bean (*Pachyrrhizus angulatus*)—A perennial, leguminous vine, native of Central America. The horizontal, starchy roots grow to be 5 to 8 feet in length and often weigh 70 pounds. Requires a rich soil. Suitable for introduction into Florida as a forage plant for hogs. It is cultivated as a garden vegetable in the Philippines. Yarrow (*Achillea millefolium*)—A perennial composite with simple stems, twice pinnately parted leaves, and white or pink flat-topped flower clusters. Common in old fields and meadows throughout the Eastern United States and extending westward through the prairie region. In this country it is usually considered a weed, but in Europe, and especially in England, is held to be a valuable addition to sheep pastures. A favorite feed for sheep in the Cascade Range, found in a great variety of situations, usually in open ground. It is very eagerly sought after by sheep. Yellow Clover (*Trifolium minus*)—A European annual, extensively naturalized in the Eastern and Southern States in sandy fields and along roadsides. It is similar to Japan clover, for which it is often mistaken. It affords a small amount of forage in early summer, but its chief value is that it spreads rapidly over the most barren soils, thereby preventing the washing of the surface. Yellow Larkspur (*Capnoides occidentalis*) A biennial, many stemmed herb, with finely dissected leaves and numerous racemes of yellow flowers. It is one of the earliest plants

to commence growth in spring. All kinds of stock are fond of it. Formerly very abundant on the ranges from west Texas to Arizona, but now all but exterminated except where protected from stock. Yellow Lotus (*Lotus macranthus*)—A yellow-flowered clover with many small leaves and tender stems. It grows on poor, dry soils in eastern Oregon and Washington. The forage is quite valuable.

Authorities Consulted on Forage Plants.—U. S. Dept. Agr. Div. Agros., Bulletin No. 2; Neb. Agr. Exp. Sta. Bul. 84; Tex. Agr. Exp. Bul. 103; Tenn. A. E. S. Bul., Vol. IV; Del. A. E. S. Bul. 1910; Tex. A. E. S. Bul. 137; Io. A. E. S. Bul. 33; O. A. E. S. Circular 81; Cornell A. E. S. Bul. 135; Florida A. E. S. Bul. 95; Penn. A. E. S. Bul. 11; Ky. A. E. S. Bul. 105; Wyo. A. E. S. Bul. 63; Wyo. A. E. S. Bul. 87; S. C. Agr. E. S. Bul. 93; Wyo. A. E. S. Bul. 22; Tex. A. E. S. Bul. 46; Penn. A. E. S. Bul. 15; Kan. A. E. S. Bul. 102; Tex. A. E. S. Bul. 40; Kan. A. E. S. Bul. 93; Ari. A. E. S. Bul. 52; Kan. A. E. S. Bul. 128; So. D. A. E. S. Bul. 61; Bulletins 2, 3, 4, Vol. XI, Tenn. A. E. S.; B. I. Vol. XIV, Tenn. A. E. S.; N. M. A. E. S. Bul. 6; same, Bul. 18; Ky. A. E. S. Bul. 98; Io. A. E. S. Bul. 38; Minn A. E. S. Bul. 40; Fla. A. E. S. Bul. 18; Wyo. A. E. S. Bul. 65; Ann'l Rep't Conn.; Mich. A. E. S. Bul. 31; Ala. A. E. S. Bul. 19; Nev. A. E. S. Bul. 62; Wash. A. E. S. Bul. 82; Minn. A. E. S. Bul. 101; Tenn. A. E. S. 5th Ann'l Rep't.; N. M. A. E. S. Bul. 33; Wyo. A. E. S. Bul. 70; same, Bul. 59; Fla. A. E. S. Bul. 16; Colo. A. E. S. Bul. 93; S. D. A. E. S. Bul. 101; Colo. A. E. S. Bul. 39; Ohio A. E. S. Cir. 49; same, Spec. Bul. 4; Cali. A. E. S. Supp. Bul. 140; N. C. A. E. S. Bul. 145; S. D. A. E. S. Bul. 96; same, Bul. 59; N. D. A. E. S. Bul. 76; Iowa A. E. S. Bul. 62; Tenn. B. 3, Vol. XIV; Ind. A. E. S. Bul. 117; Nev. A. E. S. Bul. 62; N. D. A. E. S., B. 23; same, B. 40; S. D. A. E. S. Bul. 69; same, B. 74; N. D. A. E. S. Bul. 40; Okl. A. E. S. Bul. 48; Ind. A. E. S. B. 64; Vol. VIII; Wis. A. E. S. Bul. 161; Fla. A. E. S. Bul. 60; Mich. Spec. B.; Tex. A E. S. Bul. 66; Miss. A. E. S. Bul. of 1905 and Bul. 119; Ala. A. E. S. Bul. 120; N. J. A. E. S. Bul. 161; Iowa Agr. College Bul. 1886 and Bul's. 1 and 7; Colo. A. E. S. Bul. 124; same, Bul. 68; Va. Bul. 145 and 193; N. D. A. E. S. Bul. 10; Ore. A. E .S. Bul. 76; Wash. W'n. A. E. S. Bul. 95; S. D. Bulletins 60 and 70; Va. B. 168; Ont. Dep't Agr. B. 188; Penn. A. E. S. B. V.; Ariz. A. E. S. Bul. 2· So. C. A. E. S. Bul. 76.

OTHER GRASSES.

(Not Before Treated)

Numerous varieties of grasses not included in the preceding lists as "hay," "pasture," or "lawn" grasses, etc., some of which are well known while others are not, or may have been but recently brought to light by either discovery or propagation, are yet to be mentioned. The following are extracts from descriptions found in the public documents issued by the U. S. Department of Agriculture, or the various States' Agricultural Experiment Stations concerning them.

Angola-grass (*Panicum spectabile*)—It is cultivated on the low

lands in the eastern part of Brazil, particularly in the region of Rio de Janeiro, where it is called "Capim d'Angola." This Panicum is closely related to and resembles some forms of Barnyard grass. It is spoken of as an extremely productive and nutritious fodder-grass, and may prove valuable for the low regions along the Gulf coast. Animated Oats (*Avena sterilis*).—A stout, oat-like grass, with one-sided panicles, and very large, awned spikelets; the awn is very long, twisted, and "keened" or geniculate. It is the twisting and untwisting of these awns when exposed to changes of moisture and dryness that has given to this grass the common name of "animated oats." The untwisting or coiling-up of the awn causes the spikelets to tumble about in various directions, suggestive of independent motion or life-like activity. Arizona Cotton-grass (*Panicum lachnanthum*)—This is a native of the dry regions of Arizona and New Mexico. It resembles *Panicum lanatum,* but has more slender stems, which rise from strong, woolly, and knotted rootstocks. This may prove to be a valuable pasture grass for the dry or semiarid regions of the Southwest. Annual Meadowgrass (*Poa annua*)—A low, spreading annual, with erect or ascending somewhat flattened stems, 2 to 12 inches high. This is an introduced grass, common in every dooryard and about dwellings and cultivated grounds. It may be found in bloom in the Southern States in almost every month in the year. Arrow grass or esparto (*Stipa tenacissima*)—This is a tall perennial, with long, stiff, and very tough leaves, from which ropes, baskets, mats, hats, and other articles are woven. The leaves are employed largely in England and this country in the manufacture of paper, for which purpose this grass is superior to straw. It is one of the most important articles of export from Algeria, and from northern Africa and Spain more than 2,000 tons of Esparto are exported to Great Britain annually. Ten tons of dry Esparto, worth from $18 to $25 per ton, can be obtained from an acre under favorable circumstances. The grass will grow on almost any kind of soil, from that which is poor and sandy or gravelly to heavy calcareous and clayey soils. Awned or Bearded Wheat-grass (*Agropyron caninus*)—A fibrous-rooted, rather slender, upright perennial, with bearded, nodding heads or spikes resembling slender heads of wheat. This grass is more or less frequent in the northern parts of the United States, ranging from Maine westward to the Dakotas. Bearded Wheat-grass is closely related to the more common and better known Couch-grass, but differs markedly from that species in having no creeping rootstocks, and in the longer beards or awns to the spikelets.

Bear-grass (*Stipa setigera*)—A native of California, extending northward to Oregon and eastward through New Mexico and Arizona to Texas. It is common on the coast ranges and on the foothills of the Sierra Nevada, where it is regarded as one of the most valuable of the native bunch grasses. Bearded Crowfoot (*Chloris barbata*)—This and the very similar *C. elegans* of our Southwestern States are pleasing ornamental grasses, growing to the height of 1 to 2 feet, the main stem and branches being terminated by 3 to 10 bearded spikes, which impart to them a striking appearance and make them valu-

able ornamentals. Bearded Mesquite (*Stipa leucotricha*)—An erect perennial, 1 to 3 feet high, with very narrow leaves and a loose panicle with a few long-awned spikelets. One of the best native hay grasses of central and southern Texas. Bearded Darnel (*Lolium temulentum*)—An annual grass, 2 to 3 feet high, having a general resemblance to Italian Rye-grass, but usually stouter, more strictly erect, with longer glumes and larger seeds. It has been introduced into this country with the seeds of other grasses, and is occasionally met with in grain fields and about dwellings. The grain contains a narcotic or poisonous principle, which causes eruptions, trembling, and vertigo in man and flesh-eating animals. If the seeds are malted with barley, the ale causes intoxication very suddenly. It is contended by some that perfectly healthy Darnel seeds are innocuous—that only grains which are ergotized or otherwise diseased are injurious. Bearded Saccaton (*Muhlenbergia distichophylla*)—This is a strong, firmly rooted grass, 3 to 4 feet high, with rather long and rigid leaves, and a narrow panicle often exceeding a foot in length. It is frequent in the rich valleys in Arizona and New Mexico, and on rich bottom lands it is often cut for hay. In Arizona it forms the more common "hay" that one finds in the towns and way stations, being pulled by the Mexicans or Indians and brought in on the backs of donkeys or on carts. There are many species of *Muhlenbergia* in the southwestern part of the United States and northern Mexico. Black-fruited Mountain Rice (*Oryzopsis melanocarpa*)—A rather stout, long and broad-leafed grass, with a simple panicle of a few rather large spikelets. Grows in rich, rocky woods from New England southward to Pennsylvania and westward to the Rocky Mountains, blooming in July and August. These species of *Oryzopsis* have no recognized agricultural value, but they are very hardy perennials and might be propagated to advantage in woodland parks. Black Bunch-grass (*Hilaria mutica Benth*)—This is a rather coarse perennial, with creeping rootstocks, and stems 12 to 18 inches high. It is common on the dry mesas of New Mexico and Arizona, extending eastward into Texas and Oklahoma. Where abundant it is regarded as one of the most valuable native grasses and furnishes excellent pasturage at all times when not covered with snow, and is frequently cut for hay. It forms dense patches of greater or less extent on hillsides, mesas, and plains. Blue, or White Grama (*Bouteloua oligostachya*)—This is one of the most abundant and most valued of the Grama grasses, and extends from Wisconsin westward to California, and southward into Texas and northern Mexico. It is a perennial, 6 to 18 inches high, its strong rhizomes and numerous root-leaves forming dense and more or less extensive patches of excellent turf. In Montana it is known as Buffalo-grass. It frequents the bench lands of that State, growing at elevations of from 3,000 to 4,000 or 5,000 feet, and not infrequently covers wide areas. No other grass better withstands the tramping of stock, and it is unsurpassed for grazing purposes. Branch-grass, Creek Sedge (*Spartina stricta maritima*)—An erect and often stout salt marsh grass, with flat leaves, and few to many erect spikes. It varies a good deal

in size, the larger form attaining a height of 5 to 8 feet. It grows along the ditches and creeks of the marshes, and is conspicuous by its size and long, shining leaves, which are of a deep green color. Smaller forms are found over the marshes away from the ditches, and these often are of a pale-green tint, with comparatively short and shining leaves. All the forms are somewhat succulent and have a rank odor, which is imparted to the milk and butter of cows feeding upon them. Broad-leafed Spike-grass (*Uniola latifolia*)—Erect, with rather stout, leafy stems 2 to 4 feet high, and drooping panicles of large, flat spikelets. The leaves are broad and widely spreading, and these, together with the graceful, nodding, open panicles, render it pleasing in appearance and worthy of cultivation for ornament.

Brook-grass (*Andropogon glomeratus*)—A stout perennial, 2 to 4 feet high, with dense, more or less elongated, broom-like panicles. It grows in low grounds and marshes from southern New York to Florida, also occurring in Mexico and Lower California. This species is esteemed a valuable pasture grass in the South. Broom-sedge (*Andropogon virginicus*)—A rigidly erect perennial, bearing a narrow, elongated, and loosely-branched panicle of silky-bearded racemes. The stems are strongly flattened near the base, and at maturity they are too hard and woody to be eaten by stock or to be of any value for hay. When young, however, this grass affords most excellent grazing. Milch cows fed upon it are said to yield butter of superior quality. Brown-top (*Panicum fasciculatum*)—A rather coarse and much-branched leafy annual, growing in clumps to the height of 2 to 3 feet. The leaves are flat, one-fourth to one-half an inch wide, and 2 to 6 inches long. It is a native of Texas and Florida.

Canary-grass (*Phalaris canariensis*)—An erect annual, 1 to 3 feet high, with flat leaves, and dense, ovoid panicles or heads about an inch long. This grass is apparently a native of the warmer countries of Europe, also of north Africa and western Asia. It has become widely distributed throughout the warmer temperate and tropical regions of the world, including Australia. Cultivated in Germany and southern Europe. It has been introduced into this country, and is occasionally cultivated for its seeds, which are used for bird food. The flour from the seeds is utilized in certain processes of cotton manufacture (weaver's glue), and is even employed in the making of some kinds of cake. Chess; Cheat (*Bromus secalinus*)—A well-known, weedy, annual grass, introduced into this country many years ago, and now common in grain fields and waste lands. The panicle is spreading and more or less drooping, and the awns of the flowering glumes are usually much shorter than the glumes themselves and more or less flexuose. Cheat and wheat are only remotely related; they belong to quite distinct tribes in the grass. Common Reed (*Phragmites vulgaris*)—This is one of the largest of our native grasses, growing to the height of 12 feet, the rather stout culms bearing numerous broad, spreading, and sharply pointed leaves 1 to 2 feet long. It has deeply penetrating and extensively creeping rootstocks, making it one of the most valuable grasses for binding the banks of rivers subject to periodical floods. Creeping

Beard-grass (*Oplismenus setarius*)—A slender perennial of the Gulf States, with decumbent or creeping stems, and short and rather broad leaves. It possesses no recognized agricultural value, but as it grows naturally under the dense shade of trees it might be used for covering the ground in shady places where other grasses will not thrive. Creeping Grama (*Bouteloua repens*)—A common grass in the vicinity of Acapulco, Mexico, where it occurs on the highest mountains and down their stony slopes to the water's edge. Greedily eaten by stock.

Deer-grass (*Epicampes rigens*)—A stout, erect grass, with rigid, wiry stems, and a very long, narrow, densely flowered, spike-like panicle. This grass is not uncommon in Arizona, southern California, and New Mexico, growing in sandy soil. It is regarded as one of the best native dry-land grasses, and is closely grazed wherever stock can get at it. Devil's Darning Needle (*Stipa spartea*)—This is also called porcupine grass, arrow grass, and devil's knitting-needles, from the long, stiff, twisted awns inclosing the seed. The seeds ripen early and drop to the ground, and later in the season the grass may be easily recognized by the persistent, bleached culms and empty glumes of the spreading panicle. Although somewhat coarse the grass makes a very good hay, and forms a considerable part of the wild prairie hay in Iowa, Nebraska, Minnesota, and southern Dakota. It is called buffalo grass in the Saskatchewan region. Ditch Millet (*Paspalum scrobiculatum*)—A smooth annual with branching, erect stems, 2 feet high or more. Widely distributed throughout the tropical and subtropical regions of both hemispheres. It is usually sown on the poorer kinds of soil. The straw is used for fodder. (Duthie.) A variety of *P. scrobiculatum,* called "hureek" in India, which is perhaps the Ghohana-grass, an Indian species reputed poisonous, is said to render the milk of cows that graze upon it narcotic and drastic. Downy Oat-grass (*Avena pubescens*)—This is a European grass, and has thence been introduced into this country. It is occasionally found in the grain region of the Pacific Slope. The soils best suited to the growth of this grass are sandy loams, upon which it is valuable for early mowing and pasturage. Under favorable conditions it has produced 15,654 pounds of green fodder, or 5,870 pounds of hay, and 6,860 pounds of aftermath per acre.

Early Bunch-grass (*Eatonia obtusata*)—This is a native species, growing usually in moist soil, and ranging from New York to California and southward. A tender grass, readily eaten by stock, which, when abundant, supplies considerable native forage of good quality.

Fall Red-top (*Triodia seslerioides*)—A stout, erect, native perennial, 3 to 5 feet high, with long, flat leaves and an ample, spreading, usually purple panicle 6 to 12 inches long, growing in dry or sandy fields from southern New York southward and westward to Missouri, blooming in August and September. Feather Bunch-grass (*Stipa viridula*)—A rather slender grass, growing in the Rocky Mountain region and on the foothills and mesas, from British Columbia southward to Mexico and westward to the coast. On good land, under irrigation, this grass attains the height of 3 feet or

more, and is by far the most valuable of the stipas for hay. Feather Sedge-grass (*Andropogon saccharoides*)—A variable grass, introduced into cultivation for ornament. It is a native of our Southwestern States, in some of its varieties extending southward to Chile, where it is regarded as one of the best pasture grasses. Fine Top Salt-grass or Alkali Saccaton (*Sporobolus airoides*)—A stout rather coarse and rigid grass, growing on tussocks in sandy and more or less alkaline or saline soils along rivers and streams, ranging from Montana southward to Texas and westward to California. In some places in Nevada, Utah, and New Mexico it occurs abundantly, and yields a coarse fodder, which is eaten by stock. Floating-grass (*Hydrochloa carolinensis*)—A slender aquatic grass of the Gulf States, growing along muddy banks and in shallow streams. The tender stems and leaves are eaten by stock, and may afford some food for waterfowl.

Galleta (*Hilaria rigida*).—In the driest regions of southern California and Arizona, growing in the deserts where other grasses are rarely seen. It has coarse, much branched, and woody stems, 2 feet high or more, growing in great clumps, resembling in its habit some of the dwarf bamboos. Gama-grass (*Tripsacum dactyloides*).—A tall, coarse perennial, growing in large tufts, and producing a great mass of broad leaves, which when young and succulent are eaten with avidity by all kinds of stock. When abundant it affords a large amount of natural forage, and is valuable to this extent. It has very strong, creeping rootstocks, and the quantity of forage produced is large and of excellent quality. Golden-top (*Lamarckia aurea*).—A low annual. This very attractive and favorite ornamental grass is a native of southern Europe and southwestern Asia. It is frequently cultivated in gardens and is a pleasing grass for edgings. It has escaped from cultivation in southern California and has become apparently spontaneous there. Goose-grass (*Eleusine indica*).—This grass is distributed throughout the warmer countries of the globe, and is particularly abundant in the Southern States, growing in cultivated grounds about dwellings, etc. It has somewhat wiry, flattened stems, many springing from a single root, and rather thick leaves. Some authors have spoken of it as being nutritious and good for grazing or soiling and for hay, but it is more generally regarded as a weed, and often a troublesome one, in dooryards or lawns. Great Bunch-grass (*Festuca scabrella*).—A strong perennial, growing in large tufts or bunches 1 to 3 or 4 feet high. A native of the Rocky Mountain regions, extending from Colorado northward and westward to California and Oregon. It often occupies extensive mountain parks, to the exclusion of other grasses, where it affords excellent grazing. It may be cut for hay, of which it furnishes a large amount, excellent in quality, especially for horses. It is one of the best grasses for winter stock ranges. Green Foxtail (*Chætochloa viridis*).—Similar in habit to *Chætochloa glauca,* with about the same distribution, and equally common in this country, appearing as a weed in all cultivated grounds. It begins to bloom a little earlier than the Yellow Foxtail, the more

numerous spikelets are smaller, the head or panicle less erect, and the bristles usually green, not yellow as in that species. The stems are very tough and may be utilized for making paper.

King's Fescue (*Festuca kingii*).—A tall bunch grass, common in the foothills and canyons of Colorado and Montana. It is a very robust species, and supplies a large amount of good though coarse winter forage. Knot-root grass (*Muhlenbergia mexicana*).—A much-branched, leafy perennial, with strong, scaly, creeping rootstocks, which often do good service in binding river banks, along which this grass frequently grows. In the Northeastern States this grass is common in low meadows, where it occasionally forms a considerable proportion of the native hay of such places.

Large Water-grass (*Paspalum dilatatum Poir*).—A rather coarse leafy perennial, growing in clumps 2 to 5 feet high, bearing near the summit of the stems two to ten, more or less, spreading racemes or spikes of crowded, hairy spikelets. It is a native of Brazil and possibly was originally introduced into the Southern States (where it has become quite widely distributed) from that country, although it may be a native here. It ranges northward from the Gulf to southern Virginia and Tennessee, and westward to Texas, growing most abundantly on low, black soils, which are well supplied with moisture. It is considered an excellent pasture grass, and when well established endures seasons of excessive drought without injury. Little Crab-grass (*Panicum sero tinum*).—A species related to Crab-grass common in the Southern States near the Gulf, disputing with Louisiana-grass the claim of being the most valuable native pasture grass of that section. It is invaluable for pasturage, forming a close turf, and driving out nearly all other plants. Low Grama (*Bouteloua polystachya*).—This is a small slender grass, of good quality. It rarely exceeds 6 inches in height, and is confined to the arid regions of the Southwest.

Macoun's Rye-grass (*Elymus macounii*).—A perennial grass, found quite abundantly in moist meadows, in the gravelly foothills of the northern Rocky Mountains. Many-flowered Millet-grass (*Oryzopsis miliacea*).—This is a native of central and southern Europe, introduced into California in 1879, and has been cultivated experimentally with varying success at a number of points in that State. On the granitic soil of San Diego, California, it has grown 3 feet high without irrigation, and remained green throughout the year. Horses and cattle are said to eat it greedily. Mexican Everlasting-grass (*Eriochloa aristata.*)—A branching leafy annual, native of Mexico. Seed of this grass was obtained by the Department in 1888. It will make two good crops of hay annually in the South, the best crop being from the second growth, which is ready to cut in October. The grass produces an abundance of seed and reseeds itself, making its production comparatively inexpensive. Mexican Salt-grass (*Eragrostis obtusiflora*).—A rigid perennial, abundant in the highly alkaline soils of Sulphur Springs Valley, Arizona, where the large rootstocks serve to bind the shifting sands. In the absence of other grasses it is eaten by stock. Mountain Foxtail (*Alopecurus*

occidentalis).—A grass of the mountain meadows of the Rocky Mountains, growing in rich soil along streams and in the open parks. It yields a large bulk of fine, long, bright-colored hay, which is highly valued where it can be obtained. For the more elevated meadows of the Rocky Mountain region, and doubtless also for the New England and North Middle States, this grass would form an excellent addition to the cultivated species, and its introduction is recommended. Munro-grass (*Panicum agrostoides*).—A native perennial, resembling that of Redtop. It grows in low meadows and along the banks of creeks, shores of ponds, etc., and often yields a large amount of very good native hay. Mutton-grass (*Poa fendleriana*).—Widely distributed in the Rocky Mountain region and on the Pacific Slope, extending southward through Arizona into Mexico. It grows in tufts to the height of 1 to 2 feet, has numerous long root-leaves, and short, compact heads or panicles. It is tender, and affords a large amount of excellent grazing in the regions where it grows abundantly, and may prove a valuable acquisition to the forage grasses of the Atlantic States.

Needle-and-thread (*Stipa comata*).—This is one of the bunch grasses common in the Rocky Mountain region, growing on the dry mesas and foothills. This grass has some value, affording forage of good quality in the regions where it grows abundantly. In Dakota, Wyoming, etc., it is valued as a hay grass.

Pine-grass (*Calamagrostis suksdorfii*).—A common grass in the Northwest, growing in low pine woods or on moist mountain slopes. It is said to be one of the most common grasses in Washington, and it presents all the qualities of an excellent hay or pasture grass. Plume-grass (*Erianthus saccharoides*).—This grass ranges from New Jersey to Illinois and southward to the Gulf, growing in very wet places and open swamps. Of no agricultural value, but deserves notice as an ornamental grass for lawns and gardens. Pony-grass (*Calamagrostis neglecta*).—A rather slender, native of Northern Europe and North America, ranging along our northern borders from Newfoundland and Maine to the Pacific, being most abundant in the Rocky Mountain region. Under experimental cultivation it has succeeded well. It is a productive grass, much liked by stock, especially horses, and is deserving of a place among the cultivated species. Prairie June-grass (*Kœleria cristata*).—This is a common grass upon the open meadows and plains of the Central and Western States, and extends beyond the Rocky Mountains to the Pacific Coast. It is one of the "bunch-grasses" of the plains region, where it is generally associated with the more common Bunch-grass. On the dry bench lands it is seldom over a foot high, but in irrigated ground grows to the height of 2 feet or more, and makes excellent hay. Purple-grass (*Pappophorum wrightii*).—A slender and apparently annual grass of Western Texas, New Mexico, and Arizona, growing on the open plains and among the foothills of the mountains. It has short, narrow leaves. Purple Paspalum (*Paspalum boscianum*).—Is a native of the Southern States, growing in moist grounds, preferring rather heavy soils. Like other species of Pas-

palum, it grows in tufts and often occurs covering considerable areas to the exclusion of other grasses. It yields a good bulk of sweet hay, but is rather slow in drying.

Rattlesnake-grass (*Panicularia canadensis*).—A grass growing in the Northern States, extending southward to Pennsylvania and westward to Kansas. It has received no attention from the agriculturist. The nodding panicles of rather large spikelets are sometimes gathered for dry bouquets.

Sand-bur (*Cenchrus tribuloides*).—A widely distributed grass growing in sandy soils along river banks, the seashore and more or less scattered throughout the interior of the country in sandy districts. It is one of the worst of annual weeds wherever it becomes abundant. The prostrate branching stems are 1 to 2 feet long; the spikes are composed of 10 to 15 strongly spiny burs, which readily become detached and adhere to passing objects. No pains should be spared in efforts to exterminate this grass wherever it makes its appearance. Sea Spear-grass (*Puccinellia maritima*).—A slender grass, with creeping rhizomes. It occurs in the marshes along the seacoasts of New England and the Middle States, and generally forms a valuable element of the hay of all tidewater marshes. Slender Fescue (*Festuca tenuifolia*).—This is a low and fine-leafed grass, in habit of growth resembling *Festuca ovina,* of which it is regarded as only a variety by most authors. Slender Meadow-grass (*Eragrostis pilosa*).—A slender branching annual, of some value for woodland pastures, as it will grow very well in the shade. It extends southward along the mountains into North Carolina and Tennessee. Its range westward is limited. It has a record of producing 12,209 pounds of rowen and 3,318 of dry hay per acre. Smooth Paspalum (*Paspalum læve*).—Common in the Middle and Southern States, growing in open fields, meadows, etc., usually where the ground is somewhat moist. It is a late summer grass, blossoming from July to October. Well liked by all kinds of stock. Spear-Grass (*Poa subaristata*).—A perennial, from central Montana, where it is common on dry hills and mountain slopes, forming a large percentage of the grass and supplying good pasturage. It is an excellent species for cultivation in Northern pastures. Smut-grass (*Sporobolus indicus*).—This grass is widely distributed throughout the warmer temperate regions of the world, and has become quite common in many parts of the Southern States, growing in scattered tufts or patches about dwellings and in dry, open fields. By some it is looked upon as valuable for forage, but the stems soon become too tough and wiry to be readily eaten by stock, and in fields where this grass occurs it is usually avoided by cattle when other food can be had. Stink-grass (*Eragrostis major*).—A rather showy much-branched annual, a native of Europe, has become widely distributed in this country, growing chiefly in cultivated or waste grounds, especially in light soils. When fresh it emits a strong, unpleasant odor. Sweet Vernal-grass (*Anthoxanthum odoratum*).—A perennial, early-flowering, sweet-scented grass, introduced into this country from Europe, and now widely distributed over the Eastern

and Central States. It is an inferior fodder grass, but owing to its earliness it possesses some value in mixtures for pastures, and its sweet scent adds a pleasing fragrance to hay, of which it should form only a small percentage.

Toothache-grass (*Campulosus aromaticus*).—A perennial grass with erect stems 3 to 4 feet high. Native of the Southern States from Virginia southward, growing in the wet pine barrens, possessing no agricultural value, but rather curious in appearance. The strong rootstocks are lemon-scented and have a pungent taste. Tufted Hair-grass (*Deschampsia cæspitosa*).—A native perennial, ranging from New England to Pennsylvania, and westward to the Pacific Coast. It yields an inferior, coarse, harsh forage, and is not eaten by stock except when young. It has a record of producing 10,209 pounds green and 3,318 pounds dry hay per acre.

Vanilla-grass (*Savastana odorata*).—A rather slender, sweet-scented perennial, with short culm leaves and brownish panicles. Moist meadows and mountains of the Northeastern States, extending westward to Oregon. This grass, remarkable for its fragrance, has long, creeping rhizomes, from which spring the flowering culms and numerous long-leafed sterile or flowerless shoots. These long leaves are woven into small mats and boxes by the Indians, and find a ready market because of the sweet odor, which they retain for a long time. This odor resembles that of sweet vernal grass, but is more powerful, especially when this grass is dry.

Wall Barley (*Hordeum murinum*).—A coarse, tufted annual, introduced along the Pacific Coast, particularly in California, where it has become a serious pest. At maturity the head or spike readily breaks up, and the groups of spikelets, which are sharp pointed at the base, adhere to almost any passing object; they work up the nostrils of cattle and into the fleece of sheep, and may do injury to the animals. Water Foxtail (*Alopecurus geniculatus*).—A low, usually procumbent grass, grows in wet places, and is very widely distributed throughout the north temperate zone. Under favorable circumstances this grass makes a good turf and a pleasing lawn of a deep rich green color, remaining green throughout the severe winter weather of the Middle States. Wild Rye (*Elymus canadensis*).—Common in low thickets and along streams in rich, open woods throughout the country. In the Northwest it is regarded as of some agricultural value; its cultivation is evidently worthy of trial, for if it could be successfully grown its yield of hay would be large, and, judging from appearances, the hay would be of good quality. Wire grama (*Muhlenbergia porteri*).—This grass is a native of New Mexico and Arizona, growing on the dry mesas and table-lands. It has a straggling habit of growth. It furnishes excellent feed for cattle in the regions where it grows and yields good hay. Western Wheat-grass (*Agropyron spicatum*).—A grass closely resembling the Couch-grass of the Eastern States, and by some regarded as only a variety of it. It has the same strong and extensively creeping rootstocks, and the foliage and spikes are very similar, but the whole

plant usually has a bluish color, whence the common name "Bluestem," most frequently applied to it in the West.

Yellow Foxtail (*Chætochloa glauca*).—This grass is widely distributed throughout the tropical and warmer temperate regions of the world, growing as a weed in cultivated grounds. It is especially common in the Southern States, where it continues to bloom throughout the season, from June to October.

HAY-MAKING AND HAY-MARKET.

There is considerable confusion and misunderstanding regarding the value of the different kinds and grades of market hay. The producer many times does not know what the market requires in regard to purity, or freedom from volunteer grasses, weed, etc., and quality, which depends on methods of cutting, curing, and baling. The average feeder often thinks that one kind of hay will answer all feeding purposes and pays a very high price for this kind; consequently, when other kinds which may be more valuable than the standard market hay are sent to the market, they sell at a price which is not very profitable to the producer. This is because the feeder's idea concerning the feeding value of certain kinds of hay is erroneous. As a result of these misunderstandings both feeder and producer lose money. In order that all concerned in the hay industry, namely, producer, shipper, receiver, and feeder, may each receive his share of profit from the growing, handling, or feeding of hay, it is necessary that they work together in harmony for their mutual benefit. In order to do this and place the hay business on a better foundation, the following points are important:

(1) A better knowledge by the feeder of the feeding value of the different kinds and grades of market hay would be of decided advantage to both feeder and producer. The feeding value of any kind of hay should depend primarily upon the purpose for which it is fed.

(2) Producers in general must realize that it is the feeder who makes the price of hay, and in order to secure the most profit his demands in regard to quality must be met regardless of the producer's opinion. This difference of opinion may be illustrated by the fact that in many sections timothy cut at the end of or even after the blooming period is preferred for feeding on the farm, while the city feeder prefers that which is cut nearer the beginning of the blooming period, and will pay a higher price for this kind.

(3) Growing hay for the market is profitable only when the better grades are secured and when the loss of fertility is no greater than it is in other systems of farming, such as live-stock and dairy farming.

(4) There are a number of bad practices on the producer's part that not only lower the value of the product and thus lessen his profits, but are a source of constant trouble in the disposal of the hay. It is largely on account of such practices that buyers and commission men have been led to seriously consider the problem of how to prevent low-grade hay from going to market. The writer's investigations indicate that at present three-fourths of the low-grade

market hay is the result of improper practices, such as allowing the meadow to become grassy and weedy, cutting too late, improper baling, etc., on the part of the producer, and is not caused by rain or unfavorable weather alone, as is generally supposed.

(5) In order to grow timothy hay successfully year after year, the farmer must also grow some legume crop in the rotation for either hay or pasture or as a green-manuring crop, which aids in keeping up the crop-producing power of the land.

Legume hay does not sell well in most markets, primarily because horse feeders have not yet learned the value of clover or alfalfa hay. A proper understanding of the value of these hays on the part of the feeders would be an enormous benefit to the whole hay industry.

The average horse feeder is too liable to think that the hay which is selling for the highest price on the market is the most valuable for all feeding purposes under all conditions. He should change some of his beliefs, especially in regard to some of the kinds of hay.

It is almost impossible to place a definite money value on any kind or grade of hay that will at the same time represent its true value to both producer and feeder. This is because the value may depend on several things, such as the purpose for which it is fed; the place where it is fed, for hay fed on the producer's farm has a different value to him than to the city feeder; the price of the more concentrated foodstuffs; and the size of the total crop for the United States.

When considering the profit from hay growing the farmer must consider not only the cost of production, or growing, curing, baling, and marketing, but to a certain extent the value of the fertilizing elements which the crop removes from the soil.

The feeder should value any kind of hay according to the amount of digestible nutrients which it contains, its palatability, and its efficiency in keeping the horse in good condition and enabling it to accomplish the desired amount of work.

Fertilizing Elements in Hay.—It is time for the producer to figure very closely on the cost of production, especially for the different kinds of hay. Throughout the East and South commercial fertilizers are being used in large quantities, and this practice is gradually extending westward to the great Mississippi Valley States. Every crop takes certain elements of plant food from the soil. It has been found that ordinary soil becomes exhausted first of its supply of available nitrogen, phosphorus, and potassium. It is these three elements which are bought and applied in the form of commercial fertilizers in order to get paying crops. The producer, whether he uses commercial fertilizers or not, should know that when hay is removed from the farm there is a loss of fertilizing elements which are of value to him but not to the city feeder.

There is quite a difference in the amount of plant food contained in different kinds of hay plants. For example, one ton of timothy hay contains, on an average, 20 pounds of nitrogen, 10

pounds of phosphorus, and 28 pounds of potassium. If bought in the form of a commercial fertilizer, nitrogen is worth 20 cents a pound and the other two elements are valued at 5 cents each per pound. On this basis the fertilizing value of a ton of timothy hay will amount to $5.90, or $6 in round numbers. One ton of clover hay contains, on an average, 40 pounds of nitrogen, 8 pounds of phosphorus, and 40 pounds of potassium, which makes its fertilizing value amount to $10.40.

According to these figures it would seem that there is less loss of plant food in growing timothy than when clover is grown. However, such is not the case, for clover and all other leguminous plants store up nitrogen in the soil. This class of plants is supplied with a certain kind of bacteria, which live in the tubercles on their roots. These bacteria have the power of taking free nitrogen from the air and making it available as food for the growing plant. Much of the nitrogen thus secured is left in the soil by the decay of the tubercles, roots, stems, and fallen leaves of the legumes, to the great benefit of succeeding crops.

When a ton of clover is removed from the soil, from one-fourth to three-fourths as much nitrogen is left in the roots and crowns and in the fallen leaves and stems left on the ground as is removed in the hay. As a greater part of this nitrogen came from the air, it is perfectly fair and proper when considering the loss of plant food in growing a crop of clover to disregard or deduct it from the total fertilizing value of the hay.

When comparing the loss of fertilizing elements of clover and timothy, there is a difference of about $3 a ton in favor of clover hay. Just how much of this amount should be charged to the hay when considering the profit from selling hay can not be stated definitely, for the kind of soil, system of rotation used, and type of farming play important parts in keeping up the crop-producing power of the soil.

Timothy is often said to be "hard" on the soil. This is because neither timothy nor any other grass can add any plant food to the soil in the manner that the legumes do, but must get all of its food from the soil; and it is therefore much more exhaustive of the available plant food in the soil than clover.

Need of Suitable Rotations for Hay Lands.—When crops are sold from the farm year after year and no attempt is made toward a systematic rotation, and especially where legumes are not grown, the land in the course of time will become low in available plant food and the yield will be greatly lessened. In fact, on many farms the soil has been so depleted of its fertility that farming is not a paying proposition. It has been found that when land begins to lose its crop-producing power the loss of fertility may be retarded by a proper rotation of crops in which legumes, such as clover, alfalfa, cowpeas, and soy beans, are grown.

Many farmers who in the past have grown nothing but timothy hay for the market are now commencing to grow clover in order to help build up their land. This is why under certain conditions

farmers grow kinds of hay which at present are not in greatest demand in the market. One year there is more straight clover and clover-mixed hay sent to the market than usual, and dealers sometimes have difficulty in getting enough timothy hay to supply their trade. It would seem from these observations that there is less timothy hay and more clover being grown each year, and the reasons just given show why the timothy area is decreasing.

Even though the greatest demand is for timothy, the average feeder will not suffer in any way if he is not able to get it, because there are other kinds of hay that will not only take the place of timothy but prove a better and more economical feed. Under ordinary conditions the shipper and the receiver make just as much money by handling one kind of hay as another, so that it is really better for all concerned if there is a smaller quantity of timothy hay produced than formerly. It is necessary, however, for the feeder to understand the feeding value of the different kinds of hay before there can be any great change in the demand for these other kinds, for it is the feeder who makes the price of hay in the market. In order to feed intelligently it is necessary to consider the functions of the nutritive substances.

Nutritive Substances in Hay.—The nutritive substances in hay or feed may be divided into two classes—flesh formers and fuel or energy producing substances. When the proper amount of these two classes of substances is fed the ration is said to be balanced. If an unbalanced ration is fed, as one containing more fuel or energy producing substances than are needed and less flesh-forming material, the ration is partially wasted, and such unwise feeding will not bring as good results as the feeding of the same amount of a balanced ration. Each class of substances has different offices to perform in the body. If not enough flesh-forming substance is fed, the body suffers, because it is absolutely necessary to keep the body in good condition. Thousands of horses are fed all they can eat, yet are poorly nourished because the food contains little except fuel substances. The flesh-forming substances are used to replace the waste that goes on in all living tissue. Energy-producing substances are used to furnish the energy required for the nervous and muscular activities of the body, and when fed in excess they may to a certain extent be stored up in the form of fat for use later, when needed for either energy or heat.

One of the most important substances in any foodstuff is protein. All nutritive substances which contain nitrogen are classed under the general term of protein. Protein is composed of nitrogen, carbon, hydrogen, oxygen, sulphur, and phosphorus. Protein is the substance which builds up the body. The muscles, tendons, ligaments, connective tissues, skin, hair, hoofs, part of the bone and in fact every part of the body but fat are made up of protein, together with mineral matter and water.

The next important class of substances is the carbohydrates, which contain carbon, hydrogen, and oxygen, but no nitrogen, sulphur, or phosphorus; they include starch, sugars, etc. These are

used for practically the same purpose for which coal or wood is used in the steam engine, namely, to furnish energy and heat.

The third important constituent of hay is its oils. Small quantities of oil are present in all kinds of hay. These oils serve the same purpose as the carbohydrates. A pound of these, however, will furnish two and one-fourth times as much energy or heat as the same quantity of carbohydrates. It can readily be seen, when the chemical analysis of hay is considered, why the price of the different grades or kinds of hay should depend, first, upon the amount of digestible nutrients contained, and, second, upon the purpose for which the hay is fed. If the concentrated feed—i. e., the grain in the ration—lacks protein, then the hay that is high in this substance is more valuable than one which contains little but carbohydrates, and vice versa. There is quite a range in the amount of the different classes of nutrients in the various kinds of hay.

On an average, the digestible protein in 100 pounds of alfalfa hay amounts to 10.58 pounds; in cowpea hay, 10.79 pounds; in alsike clover hay, 8.15 pounds; in red clover hay, 7.38 pounds; in redtop hay, 4.80 pounds; and in timothy hay, 2.89 pounds. In 100 pounds of redtop hay the digestible carbohydrates amount to 47 pounds; in timothy hay, 43.72 pounds; in alsike clover hay, 41.70 pounds; in alfalfa hay, 37.33 pounds; in cowpea hay, 38.40 pounds; in red clover hay, 36.15 pounds. When fed for protein, timothy hay ranks last, but when fed for carbohydrates it stands next to redtop, which heads the list. If the total nutrients are considered there are a number of different kinds of hay which are equal, if not superior, to timothy hay for feeding purposes. If cut at the right time and properly cured, Johnson grass and Bermuda grass hay are about equal to timothy in amount of nutriment contained.

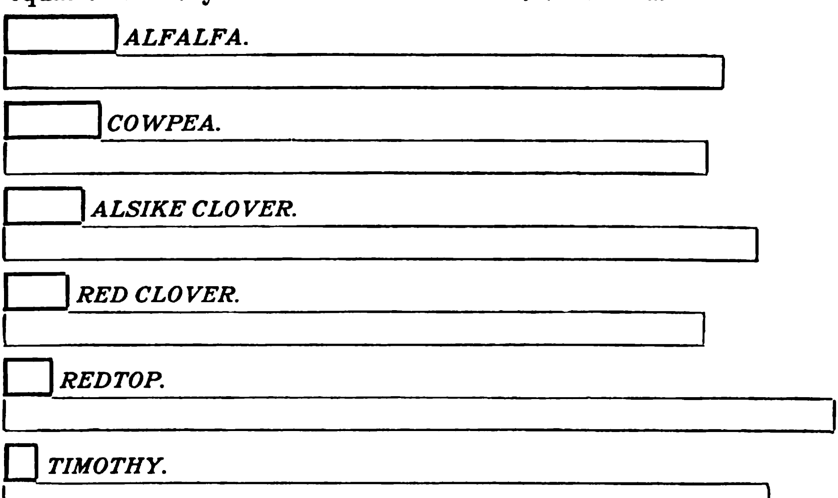


Diagram showing the relative amounts of digestible protein and carbohydrates in different kinds of hay. The sections inclosed in light lines represent the carbohydrates; those inclosed in heavy lines, the protein.

Tobacco Which Received 400 Pounds 3-8-3 Fertilizer Per Acre.

Field of Grass Succeeding Wheat Which Followed Tobacco.

Palatability of Hay.—There is another factor which is very important in determining the feeding value of hay; this is palatability. A hay may be high in nutrients, but if it lacks palatability it is not as valuable a feed as a hay that is poorer in nutrients but is very palatable. Timothy is a very palatable hay, and this is one of the chief reasons why it is standard in most markets. In addition to this, a horse can be fed a large quantity of it and will suffer no ill effects if given a hard drive immediately after having eaten the hay.

Palatability may depend largely on the time the hay is cut and on the method of curing. Redtop may be cited as an example. It is quite generally true that in most markets feeders discriminate severely against redtop whenever it is found mixed in with any other kind of hay. They claim that redtop has no feeding value and that horses will not eat it. The point that the feeder overlooks is that when redtop is cut too late it has a bitter taste, is not palatable, and horses do not relish it, but if cut early it has a sweet taste, is very palatable, and is more nutritious than timothy hay. When buying timothy that contains redtop, feeders should examine it carefully in order to see if the redtop was cut early and properly cured. If it is properly cut and cured it does not lower the quality or feeding value of the timothy, but if found to have been cut late then the bid should be lowered accordingly. It is very seldom that redtop is cut at the proper time, and it is safe to say that perhaps not over one-half of the crop is cut early enough.

Again, there are kinds of hay that when first fed appear to lack palatability, but after the horse has acquired a taste for the hay he does very well on it. On the other hand, some kinds are eaten greedily when fed for the first time. Alfalfa is a hay that is usually very palatable when first fed. In fact, for horses palatability may be an objection in some cases. Many horse feeders have tried alfalfa and are of the opinion that it is of no value for horses.

Upon careful inquiry it has been found that in a large percentage of the cases where serious results were experienced from feeding alfalfa it was on account of ignorance as to the nutritive value of the hay. Unwise use, such as feeding in too large quantities, has led many to become prejudiced against it. If alfalfa hay is properly fed it will be found one of the most valuable feeds, especially for heavy draft horses.

Digestibility of Hay.—The digestibility of the nutrients in hay is another factor that is important in determining its value. If only a small part of the nutrients is digestible, or if a part has been lost by faulty methods of haymaking, then the feeding value is lowered correspondingly. The digestibility may be lowered and the total amount of nutrients lessened by improper curing and handling of the hay.

Plants like clover and alfalfa which have a large amount of nutritious leaves often lose a considerable portion of them on account of poor methods of curing. Alfalfa hay cured under ordinary conditions will lose from 15 to 20 per cent of its leaves. The loss may amount to from 50 to 60 per cent. Alfalfa hay which has lost the

greater part of its leaves and consists mostly of stems is often found in the market; consequently, it is only about half as valuable for feeding purposes as when the greater percentage of the leaves is saved.

The Colorado Agricultural Experiment Station found that when alfalfa hay was exposed in the field for fifteen days, during which time it was subjected to three rains, amounting to 1.76 inches, the damaged hay contained but 11 per cent of protein, as compared with 18.7 per cent originally.

In an experiment to determine the loss due to rain, part of a field of grass hay was left in the cock and part in the swath during a rainy spell of eighteen days' duration. At the end of this time the hay in the swath lost 38.8 per cent of its digestible protein, while that in the cock lost only 19.8 per cent. The total nutrients lost in the swath were twice as great as those lost in the cock. This experiment shows that the value of hay cured during unfavorable weather depends a great deal upon the manner or system used in curing hay. Such things as these are of the utmost importance to the feeder. So far as it is possible to determine from an examination of the hay, the price paid should depend on its value for feeding purposes. If this were so it would stimulate the producer to make every effort to cure his hay so as to get the best quality. If he received more for the better grades it would tend to discourage the production of low-grade hay.

Aroma of Hay.—Although there is no way of determining aroma, this quality of hay adds greatly to its feeding value, or rather its palatability. There are growers who have made quite a reputation on account of the aroma of their hay, and for this reason it outsells that of their neighbors every year. There is a good reason why hay should not lie too long in the swath. When it lies too long in the sunlight the bleaching which takes place indicates that chemical changes are going on, and these are not of advantage to the hay. Hay that is cured with the least possible exposure to the sun and to dew and rain will have the best aroma.

Grassy and Weedy Hay.—One of the greatest causes of low-grade hay is the presence therein of fine grasses and weeds of various kinds. The rule for determining choice hay is that it must not contain over 5 per cent of other tame and cultivated grasses properly cured, should have a bright natural color, and should also be sound and well baled. It may happen that good timothy hay will contain quite a large percentage of other grasses and still not have its feeding value lowered in the least, although according to the rules for grading it will not grade as choice.

If the other grasses ripen at exactly the same time as timothy and are properly cured, then the feeding value is not lowered. However, it is very seldom that the grasses which so frequently occur in timothy are cut at the proper time. They are usually past maturity when the timothy is ready to cut, and hence are of but little value for feed. They make the hay appear "off color" and greatly lessen its palatability. In such cases the inspector is perfectly justified in

grading the hay down, although by so doing he may lower the grade and price just enough to take away the profits, or even cause a loss to the man who handles the hay. The reason so much grassy and weedy hay is sent to market every year is because most meadows are kept for hay too long. There are many meadows in the eastern part of the great hay section that are cut from six to twelve years. During this time the yield has become very low and weeds and fine grasses have entered to lower the quality. With such a mixture it is impossible to produce choice marketable hay, no matter how early it is cut or how efficient are the methods of curing.

How long a meadow should remain in hay is a question that can easily be determined by studying conditions, such as decreasing yield, appearance of volunteer grasses, weeds, etc. The length of time a field should remain down in hay will depend on the fertility of the soil, the treatment it has in the way of reseeding, and the application of barnyard manure or commercial fertilizers. A newly seeded timothy meadow on good soil should yield on an average from 2½ to 3 tons or more of hay the first year. After about the third year the yield begins to fall off until it will remain constant between three-fourths and 1½ tons per acre. This shows why it is so important to know when a meadow should be plowed up and a new meadow started, so that larger or paying yields may be obtained.

The Agricultural Department has made a special study of crop rotations for hay and grain farms and is willing at all times to place information in the hands of those who wish to better their conditions in regard to hay growing. In planting a cropping system it is seldom advisable to keep the meadow in hay longer than three or four years at the outside. As soon as the yield begins to lessen, the meadow should be plowed up and put into some other crop and a new meadow seeded on land which is free from weeds and other grasses.

Late cutting and the presence of weeds and weedy grasses are the greatest causes of low-grade hay. It is very seldom that timothy hay grades low simply on account of being damaged by rain. Choice hay must have a bright, natural color, according to the rules of the National Hay Association. Chemical analysis shows that when timothy is cut at full bloom it contains the greatest amount of total nutrients. If cut at the beginning of the blooming period it contains the greatest amount of digestible protein. No matter how successful are the efforts to get farmers to use better methods, the time is not likely to come when the market will become stagnant and dull on account of an overabundance of choice hay.

Low-Grade Hay on the Market.—How to dispose of low-grade hay is a vital problem with everyone who handles this class of hay, and every dealer has more or less of it, usually more low-grade hay than any other kind. The shippers, receivers, and dealers can help very much in solving this perplexing problem. The country buyer and shipper, especially, can help very materially and should use every fair means in his power to lessen the trouble caused by low-grade hay. The first step in the right direction is for the producer

to learn the different grades of hay. It is just as important for him to know the grades of hay as it is for the city buyer.

Too many farmers claim always to have good hay, no matter how late it was cut, or how much foreign material, weeds, etc., it contains, or how inefficient was the method of curing. Hay in the city markets sells on grade, and it was found out long ago that this is the only way to sell hay successfully. This being true, why not buy hay in the country according to its grade. There is no good reason why if this practice will work in the city it will not work in the country. Country buyers in many localities buy hay the year round, and the subject of grade is either not mentioned or if it is most of the hay is classed as No. 1 in order to make a sale.

There are often seen farms where the hay consists of perhaps one-half timothy and the remainder is made up of red-clover, alsike clover, redtop, Kentucky bluegrass, wire-grasses, and weeds of various kinds. When the producer is informed that the market does not want that kind of hay, he replies that he has been growing just that kind of hay for a number of years and that buyers have always taken it, and that it sold about as well as any in the neighborhood. This shows very clearly that the average producer does not know the true grades of hay, having sold inferior grades of hay for the better grades for so long that he thinks there is no reason why he should make extra efforts to grow hay that is free from other grasses and weeds and cut it at a certain time and cure it in a certain way.

If hay sells on grade in the country the man who has the poorest hay will receive less than he does now. At present the man who has choice hay receives less than it is worth on the market, and part of the profit which the shipper makes on the good hay must go to make up for the loss on the poor hay. With the present system of buying hay there is not enough difference in the price paid for the better grades in the country; therefore, if the man who has No. 2 hay receives within 50 or 75 cents as much as does his neighbor who has choice hay, he is satisfied and thinks that it is not necessary to take the precautions that his neighbor did in order to get a slight advance in price.

A firm in Illinois buys hay somewhat according to its grade. It buys a great deal of new hay as soon as it is in good condition to bale, and has a sort of sliding scale, paying the highest price for the hay that is cut early and properly cured. The price is lowered for that which was cut as it approached maturity, depending on the number of days the grass stood after the proper time for cutting. The farmers like this way of selling their hay, and make special efforts to cut it in time to secure the extra profit which the higher price paid at the beginning allows them. This way of selling is successful because farmers have learned the grades of hay and know that they must have choice hay in order to secure top prices.

The causes for hay being graded low, such as its being cut too late, the presence of weeds and fine grasses, and improper methods of curing and baling, can easily be remedied. When intelligent farmers produce low-grade hay it is not on account of the reasons

just stated, but because of rains during the haying season. The ordinary methods of curing hay in wet weather usually result in a product that has but little feeding or market value. There are methods of curing hay in wet weather by which a fair grade can be obtained, and its increased value will more than pay for the extra labor involved. The subject of curing is a large one and details of methods can not be given in this paper.

Value of Low-Grade Hay.—As long as the present system of buying is in vogue, just so long will the problem of how to dispose of low-grade hay remain unsolved. Therefore, the first thing to do to keep low-grade hay from going to market is to make a readjustment of the price paid for it in the country, so that the different grades will correspond more nearly with those for which the hay is sold in the city. If this system is adopted it will aid materially in decreasing the production of low-grade hay. If the poor hay does not go to market then the question arises, What shall be done with this kind of hay? Low-grade hay is much more valuable to the producer than to anyone else if he will feed it on his farm. This is true, first, because he will save the cost of baling and hauling, and second, because a ton of timothy hay contains fertilizing elements to the value of about $6. If fed and the manure is well taken care of and returned to the soil at least one-half of the fertilizing elements will become available for the succeeding crops.

Low-grade hay makes a fair roughage for idle work stock and other stock that are being "roughed" through the winter. After getting considerable out of the hay by feeding, there is still about $3 worth of plant food to return to the soil. As a general thing, selling crops from the farm does not represent the highest type of farming, and it is only under certain conditions that it is profitable without lowering or seriously affecting the productivity of the land.

Grades of Hay Adopted by the National Hay Association.—In order that the farmer may know definitely what are the different grades of hay, the rules of the National Hay Association, which have been generally adopted in the United States, are quoted herewith.

Choice timothy hay.—Shall be timothy not mixed with over one-twentieth other grasses, properly cured, bright, natural color, sound, and well baled.

No. 1 timothy hay.—Shall be timothy with not more than one-eighth mixed with clover or other tame grasses, properly cured, good color, sound, and well baled.

No. 2 timothy hay.—Shall be timothy not good enough for No. 1, not over one-fourth mixed with clover or other tame grasses, fair color, sound, and well baled.

No. 3 timothy hay.—Shall include all hay not good enough for other grades, sound, and well baled.

No-grade hay.—Shall include all hay badly cured, stained, thrashed, or in any way unsound.

Light clover mixed hay.—Shall be timothy mixed with clover,

the clover mixture not over one-fourth, properly cured, sound, good color, and well baled.

No. 1 clover mixed hay.—Shall be timothy and clover mixed, with at least one-half timothy, good color, sound, and well baled.

No. 2 clover mixed hay.—Shall be timothy and clover mixed, with at least one-third timothy, reasonably sound and well baled.

No. 1 clover hay.—Shall be medium clover not over one-twentieth other grasses, properly cured, sound and well baled.

No. 2 clover hay.—Shall be clover, sound, well baled, not good enough for No. 1.

Choice prairie hay.—Shall be upland hay, of bright natural color, well cured, sweet, sound, and may contain 3 per cent of weeds.

No. 1 prairie hay.—Shall be upland, and may contain one-quarter midland, both of good color, well cured, sweet, sound, and may contain 8 per cent of weeds.

No. 2 prairie hay.—Shall be upland of fair color, and may contain one-half midland, both of good color, well cured, sweet, sound, and may contain 12½ per cent of weeds.

No. 3 prairie hay.—Shall include hay not good enough for other grades and not caked.

No. 1 midland hay.—Shall be hay of good color, well cured, sweet, sound, and may contain 3 per cent of weeds.

No. 2 midland hay.—Shall be fair color or slough hay of good color and may contain 12½ per cent of weeds.

Packing hay.—Shall include all wild hay not good enough for other grades and not caked.

No-grade prairie hay.—Shall include all hay not good enough for other grades.

Choice alfalfa.—Shall be reasonably fine, leafy alfalfa of bright green color, properly cured, sound, sweet, and well baled.

No. 1 alfalfa.—Shall be coarse alfalfa or natural color or reasonably fine, leafy alfalfa of good color and may contain 5 per cent of foreign grasses, must be well baled, sound, and sweet.

No. 2 alfalfa.—Shall include alfalfa somewhat bleached, but of fair color, reasonably leafy, not more than one-eighth foreign grasses, sound, and well baled.

No. 3 alfalfa.—Shall include bleached alfalfa or alfalfa mixed with not to exceed one-fourth foreign grasses, but when mixed must be of fair color, sound, and well baled.

No-grade alfalfa.—Shall include all alfalfa not good enough for other grades, caked, musty, greasy, or thrashed.

In years when the total crop of the United States is an average one there is not much profit per ton to the producer on low-grade hay, and it is only when there is a scarcity that he can dispose of it advantageously. He should get every cent his good hay is worth and not have to help even up the price which is paid for the poor hay that others in his vicinity grow. The only way he can realize the most from his crop is to know its kind or grade, so that he can sell it intelligently.

Loss Caused by Stacking Hay.—The feeding value of hay is

often lowered when it is stacked out in the open. Considerable hay is often entirely spoiled so that it is unfit for feeding. The amount of spoiled and damaged hay depends upon the time the stack stands and upon the method of stacking. In Virginia a 6 to 8 ton stack of timothy hay, after it has gone through the sweat, or in three or four weeks, will have from 300 to 600 pounds of damaged hay. Most of this will be on the top and only a small portion on the sides and the bottom.

The market value of hay is frequently lowered because this stained hay is worked into the bales. It may happen that the spoiled hay will be no more than a couple of handfuls, which amount is really insignificant, but the inspector can not tell how much the bale contains, so he is forced to grade it one or two grades lower. This causes quite a loss to those who sell hay. In Iowa and surrounding States considerable hay is stacked in the field, and the loss due to stacking is not thought to be enough to warrant the building of a barn for hay only.

In 1907 experiments were carried on in Missouri to determine what the loss would be when timothy remained in the stack for several months. The hay was hauled with a wagon and pitched on the stack by hand, one man doing the building or stacking. Two stacks were put up in 1907 under conditions that would compare favorably with those of the average farm in this section. The first stack was baled the latter part of December. In order to find out the loss of hay at market prices it was decided to put as nearly as possible only one kind of hay into a bale.

When hay is baled by the ton it is customary for the crew to throw out the spoiled hay from the top of the stack. If the sides are badly spoiled, all that can be removed easily with a fork is also thrown out. The balance is baled with the good hay, which results in there usually being several grades in a bale.

In this experiment the sides were raked off very carefully with a garden rake and all bad spots were cut out with a hay knife. When the baling was finished there were two grades instead of several, as is often the case. These grades were a fair No. 1, and a "No-grade" hay, there being 13,990 pounds of the former and 2,870 pounds of the latter, which made the loss of unsalable hay amount to nearly 20 per cent. The second stack was baled the following March and the loss amounted to a little over 40 per cent.

The reason why the loss seemed so large was because nothing but the good hay was baled. Of course in raking out the spoiled hay a little good hay was lost, but the amount was insignificant. Had the badly stained hay been baled with the good, as is often done, the loss in pounds would have been less, but hay baled in this manner would have brought less total profit than was received by baling only the good hay. The reason for this, as stated previously, is because the presence of any stained or spoiled hay on the outside of the bale, even though it be a small amount, causes the buyer to become suspicious and think that the hay is "sandwiched." Had the stacks been put up by the use of sweep rakes and stacking machines, the

loss would probably have been less because the stack would have been more compact and not so liable to let in rain or settle with soft spots.—(F. B. 362.)

Timothy Hay.—Timothy hay is the standard of excellence with which all other hays are compared. It is heavier in proportion to its bulk than that of many other grasses, and hence is richer, but there are others which contain a larger percentage of muscle-making elements, thus furnishing a more nearly balanced ration. The amount of starch and other fat formers in clean, bright timothy hay is very large, and where it is mixed with red clover, the two together make a complete food, the excess of fat formers in the timothy offsetting that of muscle makers in the clover. A sufficient amount of seed must be sown to obtain, as nearly as possible, a good and complete stand, and it is better to make a mistake on the side of using too much than too little seed, especially when starting a permanent meadow.—(Farmers' Bul. 66.) There are individual farmers who like other grasses better, but timothy is the one grass that is universally known and grown. It has been the standard market hay so long and has so many valuable characteristics that it will require years for any other grass, even with superior qualities, to become as popular as timothy. There are many reasons why timothy enjoys this popularity. It has the best seed habits of any of our cultivated grasses. The seed is usually cheap, has a very high percentage of germination when properly matured, is easily harvested, and retains its vitality remarkably well. The hay is easily cured, stands handling well, and is relished by all kinds of stock. Unlike many grasses, a few days' delay in the time of cutting makes but little difference in the quality of the hay—a very important point in a region where showers are not infrequent during the haying season. There are several factors to be considered in determining the proper stage at which a crop should be cut for hay. Chemists tell us that hay made from young growing plants is more digestible and contains more protein per pound than hay made from more mature plants. If hay is cut early, the percentage of protein is greater; if cut later, the percentage of protein is less, but the yield of dry matter in pounds is materially increased. The protein content of hay made from the true grasses, such as timothy or orchard grass, is always low, and the gain in protein per pound from cutting such hay early is always more than counterbalanced by the loss in dry matter. On the other hand, hay made from some of the leguminous plants is said to be too rich for certain classes of animals. Men who have had considerable experience in feeding vetch and alfalfa hay generally agree in saying that either is too strong a feed for horses, especially if cut very green. For this reason hay made from leguminous crops is frequently cut much riper if for horses than when intended for other animals. Laxative feeding stuffs are undesirable for horses, but not for cows. Green hay is laxative in character, while hay cut in a more mature condition has an opposite tendency. The stage at which hay should be cut, therefore, will

depend upon the class of animals for which it is intended.—(Ore. B. 91.)

Throughout the entire timothy region the time and manner of cutting have much to do with the vitality of the soil. In all dry situations timothy develops bulbous thickenings of greater or less extent at the bases of the stalks, which become filled with water and enable the plants to survive droughty periods. If the cutting takes place too early in the season, these bulbs do not become sufficiently developed and the plants are more easily influenced by the hot, dry weather which often prevails during summer and autumn. Again, the conditions may be such that a late cutting may do serious damage to the sod. If the early part of the season has been dry and rains in July produce a second growth, the farmer usually waits as long as he can before cutting, in order to get as large a yield as possible. It is seldom that much aftermath is developed, on account of the lateness of the second growth, and if the timothy is cut too close to the ground the sod is very likely to suffer badly. Hence, a long stubble should be left. In fact, it is never a good plan to cut closer than 3 or 4 inches. When timothy is sown in the spring, it is usually best to go over the meadow with the mower to keep the weeds down, but not with the intention of cutting a crop of hay. Sometimes a little seed may be obtained the first season, but this is generally needed to fill in thin places in the sod.

The best hay is obtained by cutting during full bloom or when the blossoms fall. The feeding qualities are best at full bloom, but most farmers prefer to cut a little later, as the pollen makes the hay dusty, which is avoided by waiting. It sometimes happens that, on account of lack of moisture, the first growth is light, and abundant rains in June or July may cause a strong second growth to spring up, which will not be in its prime until the first has reached an advanced stage of development. In such cases it would be more profitable to cut late, provided the proper precautions are observed as to the condition in which the sod should be left.—(U. S. Y. B. 1896.)

Timothy hay is of little value after the seeds have been removed by the present method of harvesting. Recent experiments in Iowa indicate that by making certain modifications in the process of thrashing, timothy seed may be harvested with a stripper, such as is used for June grass, so as to save a good portion of the stalks for hay and secure a good crop of seed at the same time. Timothy seed is grown in nearly all of the Western and Middle States of this country; eastern Germany and Austria also produce a considerable amount. Austrian timothy seed, however, frequently contains dodder.—(Dept. Agr. Y. B. 1898.)

Good weather is essential for the satisfactory making of any hay, whether it be timothy, millet, clover, alfalfa or any other grass or leguminous crop. The time of day to cut hay differs greatly in different sections of the country. "As early in the morning as possible, in order that drying and curing may be quickly secured," is the advice given by the Texas Agricultural Experiment Station. "The best hour in the day for cutting is late in the afternoon," says

the Massachusetts Agricultural Experiment Station in speaking of clover hay. While, in speaking of haymaking, without particularizing as to kind in view, on a model farm in Pennsylvania, the Department of Agriculture says:

"Harvesting hay on this farm is an interesting process. The rank growth of the crop renders it necessary to move aside the swath cut before the machine can get at the next one. The method of curing is as follows: 'The grass is cut in the afternoon. The first night's dew never hurts it. Let it lie the next day until noon. It is then put into curing cocks, which are made flat. These cocks are upset the next morning, and in the afternoon four of them are made into one weathering cock. Let it stand thus for one day; then haul to the barn or rick.'"—(Dept. Agr. Y. B. 1903; Tex. E. S. B. 109; Mass. E. S. B. 134.)

In the majority of sections where timothy is most extensively grown, whether it be alone or mixed with other grasses, and frequently with clover of one variety or another, the farmer pays but little attention to the time of day; if the crop is far enough advanced to be cut, the weather appears favorable and he has nothing before him that needs his attention more, he does not delay, but sets out to cut grass or whatever the mixture may be. After being cut, and if the weather is particularly fine, timothy when but little if at all mixed can be tedded and retedded within a few hours; the hay can in most cases be sufficiently cured so as to allow of its being hauled in or stacked the day after the cutting—in some cases in the evening of the day it was cut in the early part of the morning. When, however, showers threaten and dangers from wetting by rain or dew is great, no more should be cut for the time being. That which is cut and but partially cured should be thrown into windrows, or better still into cocks. When the danger is passed, these should be opened out and thoroughly aired in order to prevent sweating and heating. This cocking, reopening and spreading for the purpose of proper curing may in some cases be required several times, the weather conditions making it extremely difficult to make good hay. If housed or stacked damp or not sufficiently cured, timothy is likely to cake, get musty and be of very inferior quality even though the stand in the field was of the very best. If, on the other hand, timothy is permitted to get too wet and remain in that condition too long before it becomes properly dried for housing, it will bleach, lose both its nutritive and palatable qualities, become straw-like in proportion to the degree that it may have thus been damaged. "The curing of hay, so as to be able to put on the market a good quality of this product, is also something which cannot be learned entirely from books, but requires considerable experience for its successful conduct."—(Dept. Agr. Y. B. 1909.)

The best hay is made with rain and with the least possible amount of sunshine. If it were possible to cure hay in the shade the quality would be much better. The curing of hay is a process of drying and of fermentation. Hot sun tends to stop fermentations

which produce hay of good quality.—(W. J. Spillman in "Farm Grasses of the United States.")

All seem to agree that hay should remain in the swath only until dry enough to be raked evenly into windrows; that most of the curing should take place in the cock rather than in the swath or windrow; and that just as quickly as it is safe to do so, it should be placed in the stack or mow. With fair weather and hot sun light crops may be raked soon after mowing, often in two or three hours. Heavier crops especially when green require more time. Being unwilted the first night's dew does not injure it. If the crop is heavy the tedder is started the next morning as soon as the dew has dried off, and the hay is gone over as many times as possible during the day. Just before evening it is raked and cocked. The hay then stands in the field for two nights and a day until the dew is off the second day. The cocks are then scattered and aired, especially the bottom portions of them, and the hay is hauled to the mow during the day. It thus requires two days from cutting to hauling. The hay is scattered evenly in the mow so that it may all settle alike and exclude as much air as possible, and is salted at the rate of 10 pounds per ton. At night the barn is tightly closed to keep out damp air.

Hay Caps.—When the price of hay is high, it is quite probable that hay caps can be used profitably in making hay west of the Cascade Mountains. The use of caps would prevent the outside of the cocks from becoming too dry, and would thus add to the total weight of cured hay. The quality of the hay would be greatly improved, for it would be practically uniform throughout. The use of caps would also greatly increase the certainty of saving the crop. A farmer in Georgia has used hay caps for ten years. He thinks they materially increase both the quality and the quantity of his hay.—(Oregon Agr. Exp. Sta. Bul. 91.)

Meadow Fescue Hay.—Seed production has so overshadowed all other interests in meadow fescue growing that only a small quantity of hay is put on the market, very little of the grass being cut at the right stage of growth to make prime hay. For this reason there is no established price for the hay in cities. Several stockmen who are growing meadow fescue for hay exclusively claim that although the hay is somewhat stemmy and inclined to be slightly laxative, it is an excellent fat producer, and when mixed with timothy and clover improves the value of these as hay for general feeding purposes.

A crop of hay is sometimes cut after the seed harvest, but this is possible only when the harvest is followed by rains and the meadow is young and vigorous. A crop of this kind is largely leaves, and if mixed with clover makes a splendid feed, fully equal to timothy and clover for most animals. It can hardly be recommended for driving horses, however, on account of its laxative effect. Meadow fescue hay is almost as palatable as timothy, and chemical analyses indicate that its nutritive value is even higher. When used exclusively as a hay crop it is cut just as it is coming into bloom, about June 20 to 25. The yield is usually 1 to 1½ tons per acre, which, however, can be increased to 2 and even 3 tons by the application of barnyard

manure. The aftermath is usually good, much stronger than timothy, and furnishes succulent pasturage until well into the winter.—(F. B. 361.)

Canada Bluegrass Hay.—There are comparatively few sections where Canada bluegrass is cut for hay, so that it can hardly be considered a hay grass. Under very favorable conditions yields of a ton to a ton and a half per acre are secured, but these are exceptions, the average being probably not more than one-half ton. It is on account of its low yield that it is not utilized as a hay grass, for it makes a very palatable hay and is above the average in feeding value. There is no definite market for the hay, but it has a ready local sale, and at points where it is well known it sells for nearly as high a price as timothy.

At Fort Erie, Ontario, where a large number of race horses are stabled, Canada bluegrass is much in demand and is considered by the horsemen there to be quite valuable. Liverymen, however, usually prefer timothy, since it is a bulkier hay and can be used more economically in feeding to transient and boarding horses, and also because it can be fed without danger of serious results. Some care must be used in feeding Canada bluegrass hay, as it has a slight tendency to produce colic in horses if fed in large quantities. If desired for hay, the grass should be cut a little before it has reached what is known as the "golden" stage. This is the stage at which it is cut for seed, but since it makes a very good hay when cut in the golden stage it is often left until then so that it may be thrashed if seed is desired.—(Canada Bulletin.)

When timothy, alsike clover, and Canada bluegrass are grown together, as is commonly the case, the combination makes a hay of excellent quality.—(F. B. 402.)

Millet Hay.—The most common use made of millets of practically all varieties is as a hay crop. It compares very favorably with timothy hay, slightly exceeding it, when properly made, both in composition and in digestibility. When wanted for hay, millet may be cut when the heads begin to appear, and on until it is in bloom. The quality of the hay deteriorates rapidly as the seed develops. Cutting should never be delayed until the seed begins to ripen. Ripe millet hay is not only much less palatable and less digestible, but the stiff hairs or beards are a source of annoyance and even danger to the stock. Millet hay is made very much as timothy. As it is usually of ranker growth it takes somewhat longer to cure it. It is well to cure it in part in the swath and, later, leave it in the cock for a few days.—(Ohio B. 225.)

It makes a desirable feed for cattle, sheep and horses, but it is well not to feed it too exclusively. The exclusive feeding of over-ripe millet has been known to injuriously affect the kidneys of horses. The short, stiff hairs of ripe millet are also harmful. Millet makes a palatable hay and is consumed with less waste than many of the annuals used as hay producers.—(Ohio B. 81.)

It is best not to cut too early, as the hay is liable to have a more or less laxative effect upon the animals eating it. However, it is

better cut early than late. The hay may be safely cut any time during the period from complete "heading out" to late bloom. The South Dakota experiment station says: "The best time to cut millet for hay is when a majority of the heads have distinctly appeared." The tough fibrous nature of the stems and the stiff beards on the heads of millet that has been allowed to approach too closely to maturity detract much from the palatability of the hay, and, although something is gained from the seeds in the way of nutriment, enough is lost in palatability and increased fiber to more than make up for it. Moreover, the earlier cut hay is a much safer food for all kinds of stock. On account of the succulency of the stems and leaves the curing takes place rather slowly, and the seeds may make a great deal of development after the plants are cut; hence, if cutting is delayed until after the seeds are well formed, they will often develop sufficiently during the process of curing to germinate. Cutting for soiling or for the silo can be done a little later than for hay, but should take place before the seed has begun to ripen.—(U. S. Year Book 1898.)

In localities where curing takes place rapidly and there is little or no rain during haying time, the self-rake and the self-binder have been used with good results. The bunches left by the self-rake are allowed to lie without further attention until cured; or possibly, in the case of a heavy yield, they may be turned over once or twice to facilitate drying. When the self-binder is used the bundles are loosely made, and are set up "two and two" in long shocks extending north and south, so that the bundles may get the full benefit of the sunshine. It is not often that this method can be employed in cutting for hay, but when practicable it saves much labor and leaves the hay in condition to be stored easily and well.—(S. D. B. 51.)

Compared with timothy, which is usually taken as the standard for grasses, the foxtail millets are somewhat deficient in the two most important constituents, fat and crude protein, but they contain about the same percentage of crude cellulose and a slightly higher percentage of extract matter. The percentages of digestibility are somewhat higher, however, in the millets, so that the actual feeding value differs but little, although the timothy is perhaps more palatable. The seed contains almost as much fat and extract matter as shelled corn, a little more protein, and about four times as much crude cellulose.—(Y. B. Dept. Agr. 1898.)

Hungarian hay is more digestible than corn stover, but rather less so than good fodder. Sixty-five per cent of the total dry matter is digestible, and of the fresh material 63 per cent. As the hay ordinarily contains from 7 to 15 per cent of water, leaving a total amount of from 85 to 93 per cent of dry matter, or 85 to 93 pounds in each 100 pounds of hay, it will be seen that the animal digests from 55¼ to 60½ pounds of the total dry matter in each 100 pounds of hay.

Barnyard-millet hay contains rather more fat and crude protein and less extract matter than the foxtail millets, and about the same amount of crude cellulose. It also has a somewhat higher percentage

of digestibility, bearing out the opinions of experts that it yields, all things considered, a forage superior to that of the foxtail and broom-corn millets.

Alfalfa Hay.—Probably four-fifths of the alfalfa of the country is utilized in the form of hay. The number of cuttings depends upon the length of the growing season and the varieties and varies from eight and sometimes nine in the extreme Southwest to two in the northern and the semiarid sections. Under favorable conditions three cuttings may be obtained in the northern portion of the country, but in very dry sections one cutting may be all that can be secured in dry seasons. From thirty to forty days of good growing weather are usually required to produce sufficient growth for a hay crop. The general rule is to cut alfalfa just as it is coming into bloom. Feeding experiments show that the feeding value is highest when the alfalfa is cut in early bloom. Results obtained at the Kansas Agricultural Experiment Station show that with hay cut when one-tenth in bloom the protein content is 18.5 per cent; when one-half in bloom, 17.2 per cent; and when in full bloom, 14.4 per cent. Cutting just as the field commences to show the blooms usually gives satisfactory results. It is safer and better, however, to watch for the starting of the basal shoots which are to form the growth for the succeeding crop. In this way the new growth is ready to take immediate possession of the ground and no delay results. On the other hand, if the cutting takes place before these shoots are formed the new growth is delayed until they can be formed. If the cutting be delayed until these shoots have attained any considerable height they will be cut off by the mower, to the injury of the succeeding crop. In case, however, dry weather retards the development of the basal shoots until after the plants commence blooming, the crop should be cut at once so as to get the best quality of hay. The methods of harvesting alfalfa hay vary considerably in the different sections of the country. The ideal everywhere, however, is to enable the hay to reach the feed lot or barn with the least possible amount of handling and exposure to the weather. In the West, where the absence of rainfall during the haying season is the general rule, the conditions for curing the hay are nearly ideal. It is the usual practice to start the mowers in the morning and rake the hay into windrows the following day. The hay is then cocked or is stacked or baled direct from the windrows as soon as it is sufficiently cured. This is usually within two days after raking if the hay is to be stacked, or three days if it is to be baled. The raking commences as soon as the leaves are wilted, but when the stems are still green. It is cocked when the stems are "half dry." It may be stacked when moisture can no longer be twisted out of a wisp of the hay. It is not in suitable condition for baling, however, until the stems will break under heavy twisting in the hand.

Alfalfa should be cut when not more than one-tenth of the plants have come in bloom. Cut at this early stage, the yield of hay for the season will be much greater than if the alfalfa is cut near maturity, and every pound of hay secured will be worth more for

feed. At the Kansas Experiment Station, a strip through a field of alfalfa was cut when one-tenth was in bloom, another strip was cut after full bloom had passed. The strip cut early was nearly ready to cut the second time when that cut after full bloom was being harvested the first time. The strip cut early grew vigorously through the season and made three cuttings and a good aftermath. The strip cut after full bloom gave a low yield the first cutting and did not grow sufficiently to yield a good second cutting. Early cuttings invigorate the plant.

The late cutting of the first crop injures the plant more than at any other time, and it is found profitable to cut alfalfa the first time as soon as one-tenth was in bloom, even though the weather was bad and though it was known that the crop would spoil in curing. The increased yield from succeeding cuttings over that cut late much more than makes up for the loss of the first crop.—(Kan. B. 109.)

Machinery for Making Hay.—In the East and Middle West it is the practice to use the ordinary haying machinery in the making of alfalfa hay. In the West, however, special machinery which results in decreasing hand labor to a great extent is used. Mowing machines cutting a swath six or eight feet in width are sometimes used on the large alfalfa fields. The rakes are the ordinary dump rakes, or, maybe, side-delivery rakes which leave the hay in a continuous windrow parallel with the swath. This is then in proper shape for loading onto the hayrack with a hay loader or for handling with sweep rakes, buck rakes, or "go-devils." At the barn or stack, hay forks or stackers do away with the necessity of hand pitching. With them it is possible to lift from 100 to 500 pounds of hay from the load and place it at any desired place on the stack or in the mow.

Importance of the Leaves for Hay.—One of the dangers to be guarded against in alfalfa hay making is the shattering of the leaves. Only two-fifths of the total weight of the alfalfa plant is in the leaves, yet three-fifths of all the protein is contained in them. In other words, 44 pounds of the leaves contain as much protein as 100 pounds of stems. Analyses show that the leaves are somewhat richer than bran for feeding purposes. Much of the loss of leaves ordinarily occurring during harvesting may be saved by proper attention to the curing operations.—(F. B. 339.)

The treatment of alfalfa for hay is practically the same as that of the grasses. It is cut when the field is about one-tenth in bloom, or as some growers put it, when the field is just coming into bloom. At this time the percentage of food materials in the plant is high, rapidly decreasing with ensuing age. From one to one and one-half tons of hay are usually secured at the first cutting of the season from a good stand of mature alfalfa. The quantity is usually smaller at each succeeding cutting of the year. The number of possible cuttings varies with the latitude, climate and other conditions. From three to six cuttings per year may be secured, the latter number not being unusual in regions of the South where the plant flourishes. Cuttings are made as early as April 15th, in some parts

of Texas. The plant is cut with a mower, preferably as early in the morning as possible, in order that drying and curing may quickly be secured.—(Tex. B. 137.)

Injury to Hay by Exposure to Rains.—Experiments at the Colorado Agricultural Experiment Station have shown that a considerable proportion of the crude protein in hay is soluble and that as much as 40 per cent may be lost by two weeks' exposure to rains aggregating a total of about one and three-quarters inches. In this particular experiment the protein content of the hay was reduced from 18.71 per cent to 11.01 per cent. This indicates clearly one of the handicaps to the successful production of alfalfa hay in sections of heavy rainfall during the haying season. Even a slight rain destroys the green color of the hay which is so characteristic of the western-grown hay cured without having been wet.

Stacking Hay.—The use of hay forks and stackers throughout the alfalfa districts makes it possible to build very large stacks. The large size of the stacks is a decided advantage, as a smaller percentage of the hay is exposed to the elements. Alfalfa hay does not shed water readily, and if barn protection or a shed roof is not provided it is commonly the practice to cover the stacks with canvas or with grass hay or millet to shed the water. A load of green alfalfa placed upon the top of the stack will on drying form a good protection to the stack.

Baling Hay.—If alfalfa hay is to be transported any considerable distance, it is usually baled. Otherwise it is fed from the stack or barn. The baling is done either from the windrow or from the stack. If from the windrow care must be taken to have the hay at the proper stage of curing so that it will not be so damp as to heat and spoil or so dry as to lose its leaves. The ordinary bale weighs about 90 pounds.

Spontaneous Combustion of Alfalfa Hay.—When alfalfa hay is stacked or put away in the barn too green it is apt to heat and may in extreme cases become so hot as to take fire and burn. In such cases if air can be excluded the hay will not burn for lack of oxygen. If this heating process is not carried too far it results in what is known as brown hay. In this form it is still well relished by stock and apparently loses none of its feeding value.—(F. B. 339.)

Clover Hay.—In order to obtain the best hay, the clover crop should be cut, as a general rule, when just past full bloom. At this stage a maximum of protein and dry matter is present, the leaves are still intact, and the stems green. After this stage the leaves begin to fall and the protein content is in other ways reduced. It frequently happens, however, that due consideration for the success of the second crop, which is usually allowed to stand for seed, makes it necessary to cut the first crop somewhat earlier than at the best haying stage in order to avoid injury from certain insect enemies. The disadvantages of cutting hay before it is in full bloom are due to the fact that the young growth is then quite sappy and considerably more difficult to cure into a good quality of hay.

The methods of harvesting red clover hay vary somewhat in

Typical Experimental Field Plats, Edgerly, N. Dak. 1908.

different sections of the country. In general it is desirable to so handle the hay that it will reach the barn or stack with the least possible exposure to the weather and the minimum loss of leaves. Clover should not be allowed to become too dry in either the swath or the windrow, else the leaves will crumble, resulting at best in a very dusty hay, to say nothing of the actual loss of much of the nutritive value. If the hay can be cocked before the leaves are entirely dry the movement of the water from the stems through the leaves will continue. When the leaves become well wilted in the swath it should be raked into windrows and then bunched into cocks when the hay is about half dry. Each cock should contain only enough hay so that two men can place the entire cock on the wagon at once, as in this way the loss of leaves due to handling is reduced to a minimum. Where a prime or choice quality of hay is desired and the rains are frequent hay caps for the cocks and canvas covers for any outside stacks are valuable devices. These hay caps can be made from a 40-inch square of canvas or ducking and may be held in place by small weights attached to each corner. Cement weights about the size of a baseball which may be attached to the hay cap by means of a hook and eye are satisfactory. Any excess of clover hay is usually baled for market, but under ordinary circumstances the farm produces only enough hay to maintain the live stock which the place supports.—(F. B. 455.)

Curing Clover Hay.—In view of the difficulty generally encountered in securing properly cured clover hay, it is believed that the following suggestions on this subject will be of interest and value to many who are engaged in the growing of clover for hay:

If it be suffered to remain until a considerable proportion of the heads are brown and the seed ripe, there will be but little rowen, while there is much danger that the roots of the clover will die after the crop is cut. Relatively early cutting then—before many of the heads are brown—is desirable, both because a better rowen crop will be secured and because the clover will persist in the mowing longer. Good weather is desired for the satisfactory making of clover hay, as it is, indeed, for the satisfactory making of any hay; but it is far more important in the case of the clovers than for timothy, on account of the fact that the clovers need much more drying. The best hour in the day for cutting, as it appears to me, is late in the afternoon. Whatever the hour, it is essential to keep in mind the fact that in the curing of clover hay it should be handled but little after it begins to dry. It is generally well understood that too much handling as the crop dries results in the breaking off of the leaves and heads, which are the most valuable portion of the crop. Whatever the hour of cutting, then, the fact should be kept in mind that this crop should be tedded but little in curing. If cut late in the afternoon, the crop may be tedded once the following forenoon. If the weather is particularly fine, it will then be ready to rake and put into cocks late in the afternoon of the same day. If the clover is curing more slowly, it may be best to leave it in windrows over one night, and to turn these carefully with the fork the next forenoon, and to cock on the

afternoon of the second day after cutting. The use of hay caps in curing clover hay should be more general. It is desirable to leave the clover in the cock for a number of days, sometimes as long as a week. The hay is coarse, and if exposed to rain it is badly damaged unless the cocks are protected by caps. When examination shows that the clover in the cock is apparently cured, it should be slightly opened and turned up from the bottom on the forenoon of a good day. It will then be ready to put in in the afternoon. Clover hay cured in this manner should hold substantially all its leaves and heads, and should cure of a bright green color. Such clover is one of the most valuable forage crops, whether for cattle, sheep, or horses. Well-cured clover hay, popular opinion to the contrary notwithstanding, is a safe and valuable food for horses, which will need much less grain when fed such hay than when timothy hay is used.—(F. B. 451.)

In making clover hay some pains must be taken to prevent a serious loss. The leaves of the clover will dry much quicker than the stems; and if the hay lies spread on the ground until the stem is dry, the leaves will be lost. The best plan is to rake it up just as soon as it is thoroughly wilted, and put it up in not too large piles, where it will cure in good weather, in from 24 to 36 hours. It is not a good plan to let it stand too long before hauling it into the barn. It may be a little tough, and apparently too wet to keep in the mow; but if there is no rain or dew on it, it will suffer no harm if packed closely in the hay mow. Do not throw open the barn doors to let in air. Keep the air away from it, and there will be no white mold or musty hay when removed. The theory of throwing open the barn doors to admit air to the hay has long since been exploded. It is no longer practiced by modern hay makers. Some farmers salt the hay in the mow. We do not, we prefer to salt the stock by hand as often as desirable.—(Idaho Agr. Exp. Sta. B. 33.)

One successful method of curing hay in use by a Tennessee farmer is to cut when half the blossoms are dead. The mower is run the entire day; the next morning, after the dew is off; the hay is raked into windrows, put into medium-sized cocks, and allowed to remain for 24 to 36 hours. The hay is forked over once to prevent heating and is then put in the barn. In threatening weather the hay is put into the barn at the end of 24 hours, but it is preferable to leave it in the field for a somewhat longer time.

Another method which has been locally successful under favorable conditions is to mow as soon as the dew is off, endeavoring by 11 o'clock to have enough cut to last the haulers from 1 to 5 o'clock in the afternoon. The newly cut clover is shaken up with a tedder before noon; at 1 o'clock it is raked into windrows, immediately bunched with the rake, and hauled into the barn. By this method the hay remains warm and free from outside moisture. The hay must be put in before 5 o'clock or the falling dew will deposit sufficient moisture to cause molding in the barn. Handled in this way clover loses none of its leaves; but it is necessary to use extreme care in not having any outside moisture on the hay, or heating in the

mow is apt to take place. For this method to be a success excellent haying weather is necessary. It frequently happens that repeated rains make a prime quality of hay out of the question where the hay is to be cured in the field. In extreme cases the silo is to be recommended as a means of making the best utilization of the rain-threatened hay crop.

Importance of the Leaves for Hay.—A considerable percentage of red clover leaves is apt to be lost during the haying process, owing to their tendency to crumble if dried rather than cured. The leaves are much richer in protein than the stems; while they constitute on an average only about 40 per cent of the total weight of the plant, they contain nearly two-thirds of the protein of the whole plant. Owing to improper methods of harvesting and to untimely rains one-half of the leaves may be lost, thus resulting in a marked deterioration in the feeding value of the hay. The table below indicates the results of the analyses of hay from a single plant of red clover cut when one-fourth the blooms turned brown and cured under cover.

Results of analyses of the different parts of the red clover plant.

Constituents	Heads.	Stems.	Leaves.	Leaf-Stalks.
Protein .... per cent..	18.25	8.06	24.63	11.16
Moisture .... do......	9.99	8.02	8.70	8.88
Ash .... do......	7.20	5.67	8.39	8.02
Ether extract (fat) .... do......	2.86	1.25	5.00	2.18
Crude fibre .... do......	10.29	34.94	13.36	13.08
Nitrogen-free extract .... do......	51.41	42.06	39.92	56.68

Stacking Red Clover Hay.—The same general rules used for stacking other hays apply to the stacking of red clover hay; but it must be remembered that red clover sheds water much less readily than the grasses and for this reason greater care is necessary in building and protecting the stack from the action of rain. It is advisable to build some kind of foundation for the stack. This foundation may be composed of poles or rails or other less valuable hay. By care in stacking a comparatively large bulge may be put on the sides of the stack. This reduces the proportion of the hay in the stack bottom and causes the rain to drain off at some distance from the base of the stack. By keeping the middle full and well trampled the hay in settling will settle in such manner as to cause the water to run off rather than into the stack. As red clover absorbs moisture readily that which lies next to the ground is almost sure to be spoiled. If canvas covers are not available for covering hay which must be left outside, it is an excellent plan to top out the stacks with green grass, straw, or millet. After the stacks have settled they should be retopped with more grass or straw, placing an additional layer as far down the sides of the stack as possible. This materially reduces the amount of clover hay exposed to the elements.

When the hay is stacked or stowed away in the barn in a slightly damp condition it is sometimes the practice to mix salt with the

same for the double purpose of salting the animals and preventing mold. If the clover must be put up when thought to be a little too green, alternating layers of straw will do much toward absorbing the excess of moisture.

Brown clover hay is made by stacking or mowing away the hay when it has just reached the wilting stage. The air is excluded and it becomes a compact mass. The hay must be free from external moisture if heating is to be avoided. There is therefore some danger of spoiling when this process is attempted by those unfamiliar with the process. This method has a further disadvantage in that the hay is very heavy at the time when it must be handled for stacking.

Cowpea Hay.—Well-cured cowpea hay is a most valuable dry forage, ranking much above the common grass hays in feeding value and being at least equal in this respect to good clover and alfalfa hay. With the area of wild grasses decreasing from year to year in certain localities, and the tame grasses in many cases failing to produce adequate yields, a heavy yielding crop with a short period of growth, like some varieties of cowpeas, becomes an important source of hay. The principal reason why the production of cowpea hay is not commensurate with its high value is the difficulty in curing the large succulent vines. Experiments in growing cowpeas as a hay crop and in handling the same economically and successfully during the curing process have been made at the Alabama, Arkansas, and Mississippi Experiment Stations among others, and the results obtained are here briefly restated in the hope that the information may be of assistance in bringing into practice more effective and less costly methods of curing, and a consequent increase in the production of this kind of hay. The Alabama Station sought to facilitate curing and to avoid the loss of the leaflets, a most nutritious portion of the plant, which readily break from the vines in curing and handling, by growing cowpeas in a mixture with some grass crop. The principal difficulty here lies in obtaining varieties which arrive at the proper stage for haymaking at the same time with the grass. On good soils German millet grown with the Whippoorwill cowpea proved useful in facilitating curing. The use of 1 peck of millet seed and 1 bushel of cowpeas per acre is recommended. If grown with a late variety the millet will be ready for cutting while the cowpea is still too immature to cure well and to make good hay. A test was made of planting Wonderful cowpea, a late variety, and drilling millet to within 6 inches of the cowpea rows seventeen days later, but still the millet ripened before the cowpea was ready for haying. While the millet did not add to the yield of hay, Amber sorghum drilled with Wonderful cowpea on May 14 gave a material increase in the yield, and was ready for mowing at the same time as the cowpea. The hay of the sorghum mixture was more moist than that obtained from the millet mixtures, and therefore is likely to present greater difficulties in curing; and this will be especially so in unfavorable weather. With these results as a basis, the station recommends growing German millet as an aid in curing early varieties of cowpea, and Amber sorghum as a means of increasing

the yield with later varieties. As long exposure to sunshine causes the leaflets to drop off, curing should be accomplished with the smallest proportion of the mown crop exposed to direct sunshine. Curing is mainly influenced by the weather and the succulence of the vines, and hence the time required for the process varies with these factors. Based on the experience in curing cowpea hay for several seasons, the station suggests the following general course of procedure: "Cutting one day and twenty-four hours later raking into windrows, where the hay may remain twenty-four hours; then cocking and, if practicable, leaving these cocks in the field for two or three days, at the end of which time they may be opened for a few hours before hauling, or hauled without opening, according to the condition of the hay." The use of canvas covers for the haycocks during wet weather was found to be very satisfactory and is believed to pay for itself in the end. An experiment in storing half-cured cowpea hay in a tightly packed condition proved unsuccessful. From several hundred plats under field conditions the Arkansas Station obtained during five years an average of 3,169.4 pounds of hay per acre. In general, the results did not include the weight of either peas or hulls. In one of the seasons the highest average yield of hay per acre, 8,750 pounds, was obtained from the Clay cowpea, and the lowest, 750 pounds, from New Era and Extra Early Black Eye, the yield of shelled peas from the three varieties being 174, 1,337.5, and 1,025 pounds per acre, respectively. A plat of Wonderful cowpea yielded 8,350 pounds of hay per acre, and two plats of Clay 8,250 and 7,450 pounds, with practically no pea production. These great varietal variations in the capacity of producing either hay or peas very forcibly calls attention to the advantage of selecting varieties suitable to the purpose for which the crop is grown. The results in curing the crops on these plats ranged from perfect success to complete failure. Young or vigorously growing vines were difficult to cure even under favorable weather conditions, while mature vines cured with little difficulty in favorable weather and usually made good hay after an exposure of two to four days of rain and cloudiness. The varieties producing few or no peas were most difficult to cure on account of their continued growth and succulent condition until checked by frost. Varieties producing the heaviest yields of peas were most easily cured into hay. Late shallow cultivation prolonged the period of growth, and in order to minimize the difficulties in curing it is suggested that if the crop is intended for hay no further cultivation be given after the first pods are formed. Vines bearing a fair or full crop of peas well ripening together were easily cured when about one-fourth of the peas were ripe and no second growth took place, while if the peas ripened through a prolonged period the plants continued in vigorous growth and were difficult to cure unless the weather was most favorable. Vines having ceased to grow and matured enough for hay may be sufficiently cured for storing in thirty-six or forty-eight hours of favorable weather conditions, and if well cocked after lying a day will endure several days of rainy weather with but slight damage and cure into good hay. On the

other hand, green and vigorously growing vines may not cure at all. The following directions for making cowpea hay are given:

The vines should be cut in the morning as soon as free from dew and when the indications are for favorable haymaking weather. The length of time the vines should remain in the swath depends upon the quantity of vine, degree of maturity, and the weather. A cloudless day, with high temperature, dry air, and high wind, will induce rapid curing, and with a combination of such conditions hay cut in the morning should usually be windrowed or cocked in the afternoon. As soon as the more exposed leaves are well cured, but not dry enough to crumble, the hay should be teddered or, in the absence of a tedder, raked into windrows. Having remained in windrows until the upper portion is well cured, the windrows may be rolled over, that the under portion may be exposed for a time. The hay is then thrown into cocks, where it remains until taken to the barn or stacked.

It is advisable to turn over the cocks a few hours before hauling in order to expose them to the sun and hasten curing. Methods of curing cowpea hay around poles are also described. The vines when thoroughly wilted are stacked about poles 7 to 9 feet long, driven into the ground, and remain there until well cured. When longer and stronger poles are used crosspieces are nailed to them at right angles to each other, about 1 foot above ground and again several feet higher, and so on to the top of the pole. The green but wilted vines are placed about the poles and over the crosspieces to the top, where the stack is drawn to a point and capped. Curing is also accomplished by piling the vines around a simple framework of poles, leaving the stack hollow in the middle, and thus admitting a free circulation of air through the center. These methods of curing, however, involve much labor and expense and are not always practicable. According to suggestions by the North Carolina Experiment Station, cowpeas should be harvested for hay as soon as the first pods turn yellow, and the cutting should be done only in the morning under promising weather conditions. The vines should be tossed during the day by means of a tedder or by hand with a fork and raked into windrows that same evening. These are turned and dried the next day and cocked. After the cocks have stood for a day and no further moisture can be wrung from the hay by twisting a handful of it with considerable force it is ready for the barn; but if moisture still appears at the twist the cocks are turned over and rebuilt to hasten the curing and the time when the hay will stand the test.

The following methods of curing cowpea hay are given by the Mississippi Station: The cutting is done when the crop is fully mature, which is about the time the pods begin to ripen and the foliage begins to change color. The mowing-machine blade is kept sharp and run as close to the ground as possible. If the pea is in rows the cutting can be done much cleaner and better with a very sharp hoe and at very little additional cost.

If the weather is good, as is usually the case when the crop is

ready, August or September, generally, the vines are raked up the same or the following day and put into cocks of the size that two men can handle with a fork when cured. They are left in the cocks for four or five days, being turned over once or twice during the time, then hauled to the barn or stack. In case they are put in a stack a good covering of grass hay is necessary in order to shed the water. The sides of the stack should be built straight up to prevent the water spoiling the outside hay.

Putting in cock is desirable because the hay is then cured by the circulation of air through it, and not in the direct sunlight. Any hay is better when cured in the shade. If the weather is damp or rainy the hay is not raked at all till cured, when it is carried directly to the place where it is to be stored. If it continues to rain for several days after cutting, do not touch the hay till ready to put up, and then be sure that it is dry when packed away. This is a precaution that must be observed in storing any kind of hay—do not put up when even moist with dew or it will mold. The crop may sometimes be lost in a protracted wet spell, but can generally be saved in such condition as to make very good forage.

Methods of putting up green are practiced and are entirely satisfactory when the vines are so packed that air can circulate freely through them. One of the methods of putting up green is to erect a stack pole and nail a strong crosspiece on the pole extending to the outer edges of the stack. Put on a layer of the green vines 2 or 3 feet thick, then nail on another crosspiece, and so on to top of stack, finishing off with grass hay. The crosspieces prevent the vines packing down closely and at the same time allow the air to enter the stack. Hay can be cured and kept by this method. It is somewhat more expensive than curing in the field, as it necessitates the handling of a great amount of water in the green vines, and the cost of stack pole, crosspieces, etc., amounts to something.—(F. B. 222.)

Feeding Value of Cowpea Hay.—The feeding value of cowpea hay has long been recognized, as it has been used extensively for all kinds of stock in the Southern States. With a fair number of ripe peas in the hay it has been found to be satisfactory when fed alone to stock at work, and can be used very successfully as maintenance ration for horses, mules, cattle, sheep, and even hogs. The farmers in the sugar-cane districts of Louisiana make a very extensive use of cowpea hay for their work stock, it being practically the only roughage used. It is generally claimed that horses or mules at work stand hot weather better when fed cowpea hay than when fed a grass hay and corn. The difference in the appearance of the animals is also very much in favor of the cowpea. In a three months' test at the North Carolina Agricultural Experiment Station the rations fed two high-grade Percheron mares, used as a team and receiving the same care and shelter, differed only in the use of 10 pounds of cowpea hay in one and the same quantity of wheat bran in the other. The horse fed bran just held its own in weight while the one fed cowpea hay gained a little. The cowpea ration was 5

cents cheaper in daily cost. At the Arkansas Agricultural Experiment Station two three-year-old steers were fattened on cowpea hay and cotton seed in a feeding trial lasting ninety days. The daily ration consisted of 13 3-5 pounds of cotton seed and 20 pounds of pea hay. The average daily gain was 3 pounds for each steer, and the cattle were in excellent condition during the entire trial. The profit realized was $21.30. The Tennessee Agricultural Experiment Station found that 6 to 10 pounds of cowpea hay could be substituted for 3 to 5 pounds of cotton-seed meal in beef production. This indicates that this hay can be utilized to advantage in place of corn and cotton-seed meal when these feeds are high priced. In the production of milk and butter, the Tennessee Agricultural Experiment Station reports that 1¼ pounds of chopped pea hay is equivalent to a pound of wheat bran, and 3 pounds of chopped pea hay to a pound of cotton-seed meal. With bran valued at $20 a ton a yield of 2½ tons of cowpea hay would mean a return of $40 an acre for the crop, based on its feeding value. Cowpea hay is equally as good as bran for producing a flow of milk.—(F. B. 318.)

Soy Bean for Hay.—When cut at the proper stage of growth and carefully cured soy-bean hay is excellent, and for dairy cattle at least yields results equal to alfalfa hay. For hay production soy bean may be planted in cultivated rows, or when the ground is free from weeds they may be drilled or broadcasted. The late or medium-late varieties are as a general thing best adapted for hay production. These varieties grow to a greater height and have finer stems and branches and more leaves than do the earlier sorts. Of the varieties now handled by seedsmen the best for hay production are the Mammoth and the Ito San. The Mammoth variety makes a very large growth of plant, usually produces a large quantity of seed, and is well adapted for growing in the entire South. The Ito San is smaller, with finer stems, and also yields satisfactory crops of grain. It is at least a month earlier than the Mammoth. Soy bean is not as a rule to be recommended as a hay crop north of the Ohio River, except in southern Illinois. The reasons for this are the shorter growing season, which tends to encourage the production of seed at the expense of plant growth, and the general culture of red clover, with which soy bean can scarcely compete in the production of hay. To get the best hay from soy bean it should be cut when half or more of the pods are fully grown, but before they begin to change color in ripening. Another rule, which is probably the better one to follow, is to cut when the top leaves begin to turn yellow. This is the best guide in most cases, but does not always apply, as some varieties, notably the Guelph, shed their leaves without change of color. At this stage of growth the largest yield and at the same time a good quality of hay will be secured. If the cutting is done earlier than this, the percentage of protein will be higher and there will be practically no waste in feeding; but the total yield will not be so large and the difficulty of curing much greater. If the cutting is much later than this, the total food constituents will be greater,

but there will also be considerable waste of material in feeding due to the stems becoming hard and woody.

Curing the Hay.—The planting should be timed, so that the crop can be cut for hay in September, as this month is usually the most satisfactory for haymaking. The cutting may begin as soon as the dew is off the plants and continue for the rest of the day. The plants should be allowed to lie in the swath until the leaves are well wilted, but great care should be exercised to rake them before the leaves become dry and brittle. After raking into windrows they should be left for a day or two, depending on the weather, and then put in small cocks or bunches. Three to five or six days of good weather is ample time for making good soy-bean hay. Great care should be used to prevent the loss of leaves, since these are the most valuable part of the plant except the pods. When the hay is dry, it should be put in good-sized stacks or under a shed. If it is stacked in the open field it is very essential that some other material, either grass or a canvas cover, be put over the stack, as soy-bean hay does not shed rain well. Yields of from 1 to 3 and occasionally 4 tons of cured hay to the acre are secured. The average yield is about 2 tons per acre. Curing frames can often be used to good advantage in making soy-bean hay, especially in unfavorable weather. The object of these frames is to keep the cocks open, so as to prevent matting and to allow the circulation of air. They are usually three or four sided pyramids made of boards or poles 3 to 6 feet long, fastened together at the top and held by crosspieces near the base. By this device a hollow cock or shock is secured, and consequent better curing. In stacking the hay, poles or logs placed in the center of stack, so as to leave passages for air, will greatly lessen the danger of spoiling.—(F. B. 372.)

Curing Sorghum Hay.—Probably more than half the sorghum grown for hay is improperly cured. Inasmuch as curing greatly affects the quality and palatability of the hay and the ease with which it can be marketed, it is a very important factor to be considered. Most frequently in curing too much sunlight is given, which darkens and injures the hay, allowing much of its flavor and aroma to escape, and aside from making hay less palatable also burns and destroys much of its feeding value. Mown sorghum should therefore never be left in the swath to cure, but should be raked into windrows and cocks as soon as thoroughly wilted, which is usually about one day after cutting. These cocks, as left by the rake, should be forked around the edges and left untouched to settle and cure. The curing usually takes about three or four weeks of sunshiny weather, and by that time it will have cured into bright, sweet, well-flavored hay. In humid regions these cocks should be made quite small, so that in case of rainfall they will dry out without molding. In some regions where the rainfall is abundant it is customary to leave the hay in the swath so as to hasten curing and thus avoid getting it wet, but it is doubtful whether curing is hastened sufficiently in this manner to justify the loss by burning. Even in such regions it might in most cases be more profitable to cure in small cocks, for

only in this manner can the best grade of hay be secured. In the drier regions these cocks may safely be made quite large. In curing bundled sorghum the same principles must be observed by putting it immediately into shocks varying in size from 12 to 60 bundles, depending on the dryness of the region. Preferably, these shocks should be large and the hay will be bright, sweet, and palatable. In the more humid regions sorghum hay should be stacked or stored immediately after it is thoroughly cured. This is not so urgent in the drier regions, because the hay is less likely to be damaged by rain; however, unless it is to be fed early from the field it should be hauled and stored as soon after curing as possible.—(F. B. 458.)

Saccharine Sorghum Hay.—Where grown for hay, sorghum may be allowed to stand until after the first light frosts if not sufficiently mature. In case a heavy frost strikes it while still standing, it should be cut at once and will be found very little injured, if at all. If left standing three or four days after such a heavy frost, it will be found unpalatable to stock. Broadcasted or close-drilled sorghum may be cut either with a mower or with a grain binder. When cut and bound with a binder, the bundles are set up in small shocks like small grain and allowed to cure in the shock. The hay may then be put in a mow or stack or fed directly from the shock. The ordinary grain binder may be adapted for sorghum cutting by an extension reel and open-end elevators. The binder is used more commonly in Kansas and adjacent territory than anywhere else. It will probably be more successful in that dry region than in moister climates, since the danger of spoiling in the bundles is considerably less. The bundles should not be too tightly bound. When cut with a mower there are two quite different methods of handling the hay. The older and probably still the more common method is to cure the hay in the swath, then in windrows, and finally in cocks, as ordinary hay is handled. This method has the advantage of getting rid of the moisture as fast as possible before the hay is handled much. The weight is thus largely decreased and the labor and expense of handling the hay are also decreased. On the other hand, the curing hay is exposed to sunshine and dew, often to rain and to frost, all of which affect its quality. It must be handled more times before the curing is finished, which in part offsets the gain of handling a smaller weight. A more recent method, and one which is growing in favor, is to allow the cut hay simply to wilt down in the swath, and then to rake it at once into large cocks, the size of which will depend somewhat on the size of the stems of the sorghum. Where it is fine and slender, the stems not larger than the little finger, it is best to make the cock not much larger than the ordinary haycock. If the stems average nearer the size of the thumb, the cock may be made two or three times as large. The cocks should be dressed down with a fork to shed water well. They are also sometimes capped with straw or hay for the same purpose. No effort is made to cure the hay before putting it in the cock, the curing being all done in the cocks. If the stems are not too large there is little

danger of molding or spoiling in any way unless under very unfavorable conditions.

It is evident that between the two extreme methods of entirely curing the hay before putting it up and of putting it into the cock while very green there are many intermediate variations in practice. The individual farmer will adapt such of these methods to his crops and climatic conditions as his own experience and circumstances warrant.—(F. B. 246.)

GRASSES OF SALT MARSHES.

No one who has traveled along the shores of New England and the Middle States can fail to have noticed the numerous hive-shaped stacks of hay thickly scattered over the extensive marshes which border these coasts. The character of this hay and the elements of which it is composed can not fail to be of interest, for they are wholly unlike those of other regions; and the hay itself, while less valuable than that usually found in our markets, serves many a useful purpose and forms a very important item of local trade. In olden times the products of the salt marshes were not forgotten by the coast dwellers of New England in their annual acknowledgment of blessings bestowed by Providence, when thanks were returned upon the day which is now one of national observance. The area of the salt and tide-water marshes bordering the ocean and gulf coasts of the United States is roughly estimated at from 6,000,000 to 7,000,000 acres. A considerable portion of this, particularly along the river banks of the Southern States, is beyond the reach of salt water, and possesses a different vegetation from that which comes under the direct influence of the sea and which alone is considered here. The hay product of the marshes varies from half a ton to a ton or more per acre, and is harvested at any time from June to December, little attention being paid to the time of blooming of the grasses of which it is composed. When the marshes are firm enough to allow the use of machinery, the grass is cut with a mower, but in many cases this is impracticable and the cutting is done by hand. Occasionally it is necessary to take advantage of very low tides to carry on the operation of harvesting. After being cut the hay is raked, and if it can not be dried upon the marsh it is carried to the adjoining uplands, and there spread out to cure. More frequently it is stacked upon the marsh and hauled away during the winter season when the lands are frozen. The hay is taken to the stacks in various ways. One method, observed on the coast of Maine, was this: The hay was cut and then raked up into small bundles; two poles were run under these bundles, and then the hay was carried to the stack and placed upon it. In this particular case the hay was cut upon shares, the harvester being allowed two stacks out of three for doing the work.

This hay, the value of which was given at $5 per ton, was designed in part to be used for fodder and litter, and in part to be sold in Portland for packing glassware and crockery. This latter is a very common use of salt hay in the vicinity of all the larger seaport towns, immense quantities of it being used in New York City for this purpose; the fine, and rather stiff, wiry stems of the grasses

peculiar to the marshes being particularly well adapted for packing purposes, much better than the hay of the uplands. The better quality of marsh or salt hay makes very good feed for growing stock, but possesses little fattening value. Some of the grasses composing the hay impart a disagreeable flavor to the milk or butter of cows feeding upon it. The grasses of the seacoast may be divided into three classes: Those growing in the sands along the shore, those upon the marshes proper, and those upon the sandy and waste lands bordering the marshes. To the first class belong beach or marram grass and a few others to some extent valuable for holding drifting sands.

A sample of salt hay, collected near Pine Point, Me., in the early part of August and made up of a variety of grasses, including black grass, fox grass, and browntop, analyzed as follows: Moisture, 8.04 per cent; ether extract, 5.44; fiber, 27.25; ash, 5.13; nitrogen, 0.94; nitrogen as albuminoids, 5.88.

The following table of analyses of the more important grasses here mentioned with those of the common meadow grasses inserted for comparison is taken from the annual report of the Connecticut Agricultural Experiment Station for 1889, page 240. The samples analyzed were gathered just before or at the time of blooming.

	Timothy and red top.	Mixed meadow grasses.	Black grass (*Juncus gerardi*).	Red salt grass (*Spartina juncea*)	Creek sedge (*Spartina stricta*).
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Ash	5.5	5.5	7.9	9.3	11.7
Albuminoids	7.4	7.6	9.2	6.0	7.2
Fiber	34.4	35.6	29.0	28.6	29.4
Nitrogen-free extract	50.4	48.9	51.3	53.4	49.5
Fat	2.3	2.4	2.6	2.7	2.2
Total	100.0	100.0	100.0	100.0	100.0

The average of numerous analyses of the ash of some of these grasses shows that 5 tons of hay made from them contain as much nitrogen, phosphoric acid, and potash as is contained in a full crop of corn, including stover, from an acre of land. The average amount of salt contained in a ton of hay, according to the investigation at the Connecticut Agricultural Experiment Station, was 54 pounds.—(Y. B. 1895.)

The marsh grass near the great inland lakes, large rivers and as it may be found in many other localities throughout the country, is also harvested to a great extent in about the same manner as the above.

TAME HAY AREAS OF THE UNITED STATES.

According to the census report, 75 per cent of the tame hay (not including alfalfa, clover, and grain cut green for hay) in the United States is produced in ten States. For all practical purposes, the "other tame grasses" cut for hay referred to in the report may be regarded as timothy, especially in the northeastern part of the

United States. The percentage of the total crop that each State produces is as follows: New York, 14.3; Iowa, 10.7; Pennsylvania, 8.6; Missouri, 7; Illinois, 7; Ohio, 7; Michigan, 6; Wisconsin, 6; Indiana, 4.4; Minnesota, 3.2. Three-fourths of the clover hay was grown in ten States, the percentages being: Indiana, 18.4; Ohio, 12.1; Missouri, 9.5; Illinois, 8.4; Pennsylvania, 6.5; Wisconsin, 5.8; Michigan, 5.1; Iowa, 4.5; Kansas, 4.1; Kentucky, 3. In 1900, 75 per cent of the alfalfa was grown in six States, as follows: Colorado, 21.2; California, 16; Utah, 13.5; Kansas, 11.5; Idaho, 8.1; Nebraska, 5.2.

Hay.—Wheat has often contended with hay as to precedence in value and the place in 1910 went to hay, notwithstanding its short crop. The value of the hay crop is about $720,000,000, an amount which has been exceeded but once, and that in 1907, when the crop was worth $744,000,000. Indeed, the value of the crop of this year is much above that of the high crop values of other preceding years, illustrating the principle that a somewhat deficient crop is usually worth more in the aggregate than an abundant one. The value of the crop of this year is 13 per cent above the average of the preceding five years.

The quantity of the hay crop is 60,116,000 tons, and has been exceeded a dozen times. It is 5 per cent below the average crop of the preceding five years. The feeding value of the hay crop, however, is greater than its tonnage implies. Alfalfa has entered into the production of this crop in recent years and has now become in itself a crop of large proportions.—(Year Book 1910.)

Price of Hay for Forty Years.—The price received for hay is the governing factor in determining the profits in growing hay. As shown by statistics, the average farm value of hay per ton for the first five-year period of the forty years from 1865 to 1905 was $10.61 for the United States and $8.75 for the ten leading timothy-hay-producing States. The highest five-year period for both groups was from 1870 to 1875. These prices have not been equaled since that time, although the farm value since 1900 is higher than it has been since 1885. The average farm value per ton for the forty years was $9.30 for the United States, as compared with $8.58 for the ten timothy States.

Increasing Value of Hay Lands.—There is no doubt that during the forty years from 1865 to 1905 farmers have made money when growing the average yield of nearly a ton and a half and selling it for approximately $9 a ton, but within the last few years another factor has entered which has greatly changed the profits on hay growing for the market. This is the increasing value of hay and grain land. The following table shows the increase in value of such land in some of the States in the northeastern section of the United States.

Average real estate value per acre of medium farms with at least two-fifths of income derived from hay and grain, 1900 and 1905.

State	Value in 1900	Value in 1905	Increase during five years	
				Per cent
New York	$40.29	$44.38	$ 4.09	10.2
Pennsylvania	40.24	43.95	3.71	9.2
Ohio	48.34	58.34	10.00	20.7
Indiana	43.84	57.67	13.83	31.5
Illinois	57.24	78.89	21.65	37.8
Michigan	30.01	36.39	6.38	21.3
Wisconsin	36.44	47.19	10.75	29.5
Minnesota	28.11	35.04	6.93	24.7
Iowa	51.95	66.10	14.15	27.2
Missouri	25.54	36.09	10.55	41.3
North Dakota	11.03	18.82	7.79	70.6
South Dakota	14.54	24.00	9.46	65.1
Nebraska	23.32	36.58	13.26	56.9
Kansas	17.47	27.53	10.06	57.6

The increase in value per acre ranges from 20 to 70 per cent for the States west of Pennsylvania. The increased yield per acre and price per ton during this time is insignificant when compared with the large increase in value of hay land. The point to be remembered is this, that as land increases in value the yield per acre must be increased in like proportion in order to realize the same profit on the investment, provided the price per ton remains the same or nearly so.—(F. B. 362.)

All haymaking is, of course, subject to the same kind of possible drawbacks, and hence the same methods for curing and saving whether it be under favorable or adverse conditions are applicable to the one variety as well as to the other.

Hay-Farming.—Hay is one of the most profitable cash crops. It will be seen that hay or potatoes, or both, combined with market milk, make one of the most profitable types of farming. Some farmers depend nearly altogether on hay. Of 605 farms operated by owners, seven sold over $1,000 worth of hay. The average labor income by the men was $1,127. Two of them had 100 acre farms and made labor incomes of $1,132 and $1,437. The other five had large farms, and three rented additional land. They farmed an average of 277 acres each. These men are making good profits. They are not making provision for keeping up the fertility of their farms, as they do not keep much stock or buy much fertilizer. Temporarily this type of farming is sometimes desirable. A young man who buys a farm and has not money enough for stocking the place may often find it profitable to depend almost entirely on hay for a year or two until he gets a start. It seems possible that hay-farming might be made more profitable and at the same time keep up the fertility of the land by the proper use of fertilizers. At Rothamsted, England, the yield of hay has been kept up and improved for sixty-six years by using commercial fertilizers. Fertilizing hay has received almost no attention in this country. The combination of stock and hay, with fertilizers on hay would probably pay still better.—(Cornell Bul.)

The possibility of curing hay by artificial drying has been shown to be practicable for regions like the South, where it is difficult to cure hay because of untimely rainfall. A drier that cures green alfalfa in 25 minutes into a very superior hay at a nominal cost has been designed and constructed by the Department.

In relative geographic distribution, the hay crop has changed perceptibly during the twenty-one years since the census year 1889. During the interval the North Atlantic States have increased their production of the National crop from 24.3 to 27.8 per cent; the Western division, 7.9 to 16.4 per cent; the South Atlantic, from 3.1 to 3.9 per cent; the South Central, from 3.3 to 5.8 per cent; the two southern groups of States, from 6.4 to 9.7 per cent; and consequently, the North Central States have lost relatively in a marked degree, or from 61.4 to 46.1 per cent of the National crop.—(U. S. Year Book 1910.)

In nearly all parts of the country, hay of any kind, when intended for shipment, is baled at the opportune time. It should always be in the best condition possible before baling. The hay, sold by farmers for local consumption, is generally sold loose. The following table will sometimes aid rapid computation.

RECKONING OF AMOUNT AND VALUE OF HAY.

Four hundred cubic feet of hay is roughly estimated as a ton. But there is great variation in the ratio of weight to volume, dependent upon the kind of hay, time of cutting, and treatment in storing. In general, the finer the stalk of the plant the heavier the hay; also, of course, the more closely packed in putting away and the nearer the bottom of the mow the heavier. Grass allowed to stand till nearly ripe before cutting will be the lighter.

In estimating by measurement multiply together the figures representing the length, width, and height of hay, and divide the product by the number of feet in a ton. For example, if the hay is 40 feet long, 16 feet wide, and 18 feet from the bottom to the top of the mow, and the bulk agreed is 400 feet to the ton, the mow will contain 40 times 16 times 18, which equals 11,520 cubic feet; 11,520 divided by 400 equals 28 tons and 320 cubic feet, or 28.8 tons. The following table is from the American Agriculturist annual.

Lbs.	$4.	$5.	$6.	$7.	$8.	$9.	$10.	$11.	$12.	$13.	$14.	$15.	$16.	$17.	$18.
50	0.10	0.13	0.15	0.18	0.20	0.23	0.25	0.28	0 30	0.33	0.35	0.38	0.40	0.43	0.45
70	.14	.18	.21	.25	.28	.32	.35	.39	.42	.46	.49	.53	.56	.60	.63
90	.18	.23	.27	.32	.36	.41	.45	.50	.58	.59	.63	.68	.72	.77	.81
100	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90
300	.60	.75	.90	1.05	1.20	1.35	1.50	1.65	1.70	1.95	2.10	2.25	2.40	2.55	2.70
400	.80	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.25	3.40	3.60
500	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50
700	1.40	1.75	2.10	2.45	2.80	3.15	3.50	3.85	4.20	4.55	4.90	5.25	5.60	5.95	6.30
900	1 80	2.25	2.70	3.15	3.60	4.05	4.50	4.95	5.40	5.85	6.30	6.75	7.20	7.65	8.10
1,000	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00
1,200	2.40	3,00	3.60	4.20	4.80	5.40	6.00	6.60	7.20	7.80	8.40	9.00	9.60	10.20	10.80
1,500	3.00	3.75	4.50	5.25	6.00	6.75	7.50	8.25	9.00	9.75	10.50	11.25	12.00	12.75	13.50
1,600	3.20	4.00	4.80	5.60	6.40	7.20	8.00	8.80	9.60	10.40	11.20	12.00	12.80	13.60	14.40
1,700	3.40	4.25	5.10	5.95	6.80	7.65	8.50	9.35	10.20	11.05	11.90	12.75	13.60	14.45	15.30
1,800	3.60	4.50	5.40	6.30	7.20	8.10	9.00	9.90	10.80	11.70	12.60	13.50	14.40	15.30	16.20
1,900	3.80	4.75	5.70	6.65	7.60	8.55	9.50	10.45	11.40	12.35	13.30	14.25	15.20	16.15	17.10
2,000	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.10	18.00

The price per ton of 2,000 pounds being known, it is very easy to find the value of any fraction of a ton at $4 to $18 per ton. If a farmer has 1,565 pounds of hay on his wagon, and the dealer has bought it at $7 per ton, he finds, by looking across the table from 1,500 pounds to the column at the top of which is $7, that the value of 1,500 pounds at $7 per ton is $5.25, the value of 60 pounds 21 cents, and the value of 5 pounds 2 cents, making a total of $5.48. If the price was $7.50 per ton, he would also find the value of 1,565 pounds at 50 cents per ton, and add it to $5.48, the value at $7 per ton. To find the value at 50 cents, first find it at $5, and take one-tenth of that sum. The value of 1,500 pounds at $5 per ton is $3.75, at 50 cents, 37.5 cents. The value of 60 pounds at $5 per ton is 15 cents, and at 50 cents it is 1.5 cents, making a value of 1,565 pounds at 50 cents per ton, 39 cents, which sum, added to $5.48, gives $5.87, the value of 1,565 pounds at $7.50 per ton.

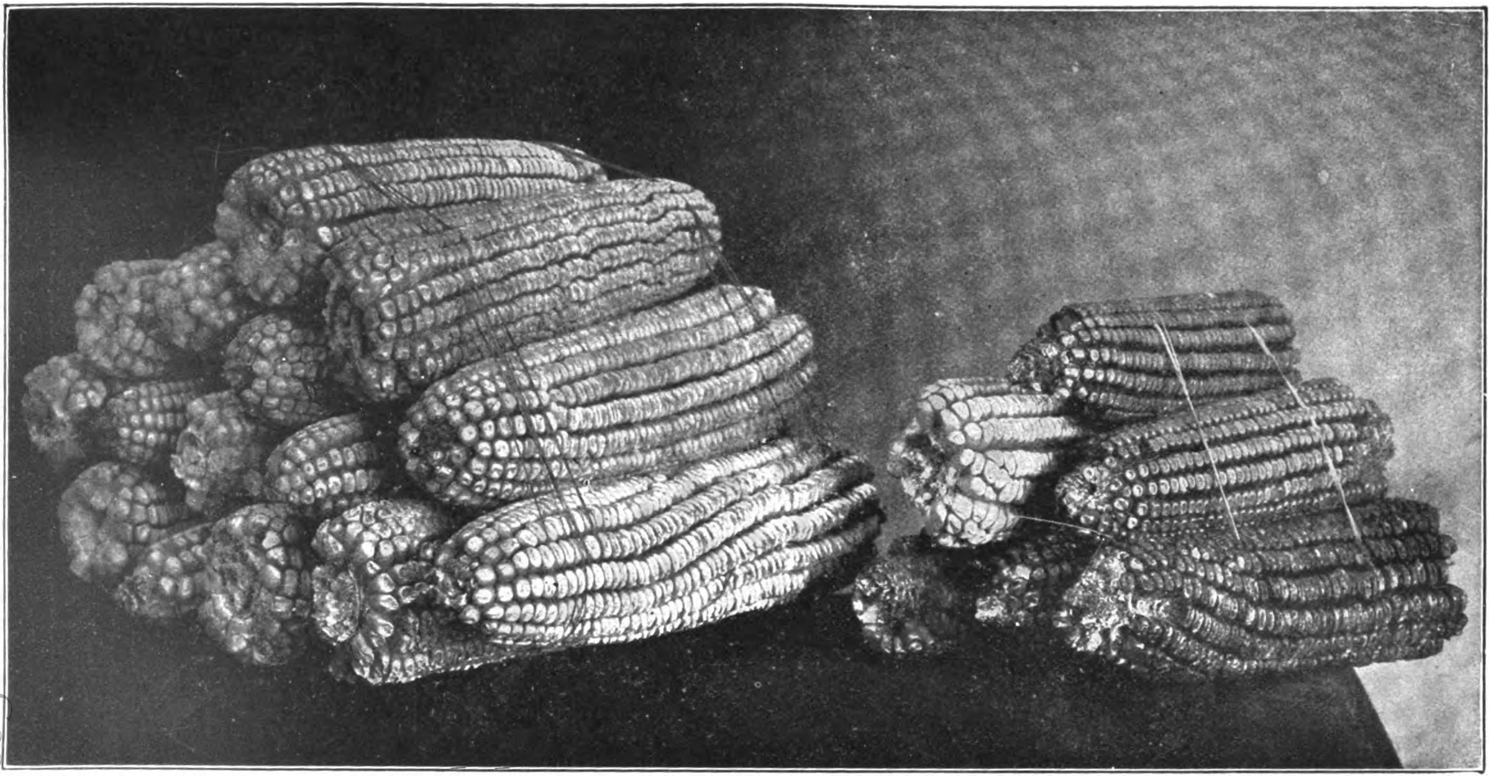
To find the value of any fraction of a ton at $7.40, $7.60, $7.70, $7.80, or $7.90, find the value at $7 and add to it one-tenth of the value at $4, $6, $7, $8, or $9.

To find the value at $7.30, add one-thirtieth of the value at $9 to the value at $7.

To find the value at $7.25, add one-twentieth of the value at $5 to the value at $7; and to find it at $7.20, add one-twentieth of the value at $4 to the value at $7. To find the value at $7.10, add one one-hundredth of the value at $10 to the value at $7.—(Y. B. 1898.)

Spontaneous Combustion of Hay.—Fires which are reported to be caused by the spontaneous combustion of hay are by no means rare. While some of them are doubtless of an incendiary origin, others are really due to the cause assigned. Such a case was recently reported by the Pennsylvania Station. The fire was discovered in the haymow of the station barn. The mow was directly over the cow stable. Precautions were taken to exclude drafts and, as there was a sufficient supply of water available, the fire after a time was extinguished. The fire was confined to the central portion of the hay and a number of holes were burned through the ceiling of the cow stable. These were so situated that it apparently would have been impossible for the fire to have originated from any other cause than spontaneous combustion. A considerable part of the hay was thrown out of the mow. An examination showed that a large portion of it was so thoroughly charred that it would crumble. Some of the hay had not been subjected to so great heat and was only browned in color. However, it was unfit for stock feeding.

For several days previous to the fire a peculiar odor had been noticed about the barn and a somewhat careful examination was made to ascertain its source. The result of this examination seemed to indicate that the rowen in this mow was heating, but no indication of fire was seen or even suspected. This odor was noticed not only by men working about the barn, but by other persons who had occasion to pass on the leeward side within forty or fifty rods of the barn. The odor was so strong that it was observed by many people and compared by some to that of burning grain. While positive proof as to the



SEED SELECTION. ON RIGHT BY FARMERS WHERE NO DEMONSTRATION WORK HAD BEEN DONE; ON LEFT WHERE DEMONSTRATION WORK HAD GONE ON ONE YEAR.

(See page 400)

origin of this fire may be lacking, the circumstances are such that it seems safe to consider it of spontaneous origin.

It is well known that when moist hay is stored under favorable conditions fermentation takes place, which may produce a considerable amount of heat. According to recent investigations made in Germany, the amount of heat may be sufficient to set fire to the hay. Under suitable conditions some of the organic matter of the hay is oxidized by the oxygen of the air. Carbon dioxid and water are produced. The water moistens the hay and the moistened material ferments. Fermentation produces carbon dioxid, water, and small amounts of other compounds. Heat also is produced. The fermentation is more active if the material is moistened at the beginning. However, the water produced by the oxidation of the materials is sufficient to start it. This fermentation produces a temperature of about 132.8° F. At this temperature a second and more violent oxidation takes place and the temperature rises to about 194° F. Other processes then take place which char the material and cause a slow rise of temperature to 266° F. When this temperature is reached, the hay chars rapidly. All these processes destroy at least half of the material present. Theoretically, the temperature may rise to 374° F. According to the tests made, clover hay will become ignited at 302°-392°F.

Spontaneous combustion is indicated by the hay becoming darker in color until it is finally black, by a sooty odor, and by smoke irritating to the eyes. The ash of the burned hay has a characteristic grayish-white appearance and feels like sand. The burned hay is surrounded by a layer of charred but not burned material, which is a poor conductor of heat.

(*Authorities Consulted on Grasses.*—U. S. Dept. Agr. Botanical Div. Special Bulletin; do. Div. Agros. B. 14 and B. 15; N. J. Agr. Ex. Sta. B. 207; Tex. A. E. S. B. 103; Mass. A. E. S. B. 134; Tenn. B. 1, Vol. IV; N. H. A. E. S. B. 129; S. Dak. A. E. S. B. 66; Mont. A. E. S. B. 36; Neb. A. E. S. B. 84; Tenn. Parts I. and II. Bul. 1892-94; Iowa A. E. S. B. 54; B. 56; Tex. A. E. S. B. 59; Vt. B. 149; R. I. B. 103; Iowa B. 83; N. J. B. 190; R. I. B. 82; Minn. B. 20; Ariz. Timely Hints Cir.; Ind. B. 29; Kans. B. 86; Va. B. 180; La. Ann'l Rpt. 1901; Wyo. B. 46; Colo. B. 61; Ky. B. 124; Okl. B. 70; N. Dak. B. 47; Kans. B. 141; Nev. B. 33; Okl. B. 55; Tenn. B. 4, Vol. II.; Mich. B. 20; Ore. B. 19; Kans. B. 87.)

PART II

THE VEGETABLE GARDEN

PERHAPS the most characteristic feature of Northern and Eastern farms is the home vegetable garden. Even where no orchard has been planted, and where the ornamental surroundings of the home have been neglected, a fairly well-kept garden in which are grown a number of the staple kinds of vegetables is generally to be found. In many cases the principal interest in the garden is manifested by the women of the household and much of the necessary care is given by them. A small portion of the garden inclosure is generally devoted to the cultivation of flowers, and a number of medicinal plants is invariably present. Throughout the newer parts of the country it is seen that the conditions governing the maintenance and use of the vegetable garden are somewhat different, and, while a number of vegetable crops may be grown somewhere on the farm, there is wanting that distinction so characteristic of the typical New England kitchen garden.

It would be impossible to make an accurate estimate of the value of crops grown in the kitchen gardens of the United States, but from careful observation the statement can safely be made that a well-kept garden will yield a return ten to fifteen times greater than would the same area and location if devoted to general farm crops. A half acre devoted to the various kinds of garden crops will easily supply a family with $100 worth of vegetables during the year, while the average return for farm crops is considerably less than one-tenth of this amount. A bountiful supply of vegetables close at hand where they may be secured at a few moments' notice is of even more importance than the mere money value.

Fresh vegetables from the home garden are not subjected to exposure on the markets or in transportation and are not liable to become infected in any way. Many of the products of the garden lose their characteristic flavor when not used within a few hours after gathering. By means of the home garden the production of the vegetable supply for the family is directly under control, and in many cases is the only way whereby clean, fresh produce may be secured. The home vegetable garden is worthy of increased attention, and a greater number and variety of crops should be included in the garden.—(F. B. 255.)

The development and extension of truck farming in the Atlantic coast States have been coincident with the development of transportation facilities throughout that section. In the beginning the points affording water connection with the great consuming centers

of the North were those at which truck farming first became established. The phenomenal growth of the great consuming centers of the country has stimulated a corresponding growth and extension of the food-producing territory, especially that capable of producing perishable truck crops. The demands for vegetables out of season, followed later by the continuous demand for fresh vegetables throughout the year by the great cities, led first to the market gardeners located near the cities supplementing their field operations by extensive forcing-house enterprises. Naturally, the products from the greenhouses were expensive and available only to the few who were able to pay fancy prices for green products out of season. The improvement and extension of the transportation facilities which came with the great railway-building era of the United States made it possible to take advantage of the wide diversity of climate offered along the Atlantic coast of the United States to furnish these perishable products to the great cities of the North and East.

Transportation facilities, together with cheap labor and cheap lands at the South, have made it possible to produce in extreme southern locations products out of season at the North in competition with greenhouse products. The greater land area and the smaller amount of capital involved in the production of crops at the South, even though transportation charges were high, have enabled southern growers to produce much larger quantities of the desired crops than could be grown profitably under glass. It was therefore not many years before lettuce, celery, tomatoes, radishes, beets, and bunch beans came to be regular winter and early spring products of gardens located at great distances from the centers of consumption. —(Y. B. 1907.)

It is only necessary to look around the village and town gardens in the South to become convinced of the great need that exists for information in regard to the proper care of the garden, and particularly that part which is intended to give supplies to the table. There town gardeners are very active in the early spring, and their enthusiasm often leads them to go ahead and plant a great many things at a season too early for their safety, so that a return of cold often compels the almost entire replanting of the garden. But with the production of the early crops in the garden, the enthusiasm of the gardeners oozes out under the influence of the summer's heat, and the garden that at first looked so neat in its spring dress becomes merely a weed patch. Few people realize the advantage that long summers and sunny autumns give for the production of a constant succession of crops in the garden, and still fewer realize that in this climate the garden need at no season of the year be abandoned to the weeds. One of the greatest troubles that results from the common practice of allowing the garden to grow up in weeds after the first peas, corn, cabbage, and tomatoes are secured, is that these weeds are the places where the larvæ of the cut-worm hide, and are ready to begin their destructive work as soon as the garden plants are set in the spring. If the garden is kept clean and cropped continuously all the year round, as it may and should be here, there

will be no cut-worms to bother the early plants. From January to January there is no need in in the South for any space in the garden unoccupied by crops. From the time the earliest peas go into the ground in January up to the time it is necessary to prepare for them the following year there can be a constant succession of fresh vegetables from the garden, by the exercise of a little forethought. And this succession can be made still more perfect if there be added a frame with some hot-bed sashes for the production of lettuce, cauliflower, radishes, carrots, etc., during the colder months; while all through the winter there can be celery, kale, spinach and turnips.—(N. C. Bul. 132.)

LOCATION.

The question of the proximity to the house or other buildings is of great importance when locating the garden. Caring for a garden is usually done at spare times, and for this reason alone the location should be near the dwelling. In case the site chosen for the garden should become unsuitable for any cause, it is not a difficult matter to change the location. Many persons prefer to plant the garden in a different location every five or six years. The lay of the land has considerable influence upon the time that the soil can be worked, and a gentle slope toward the south or southeast is most desirable for the production of early crops. It is an advantage to have protection on the north and northwest by either a hill, a group of trees, evergreens, a hedge, buildings, a tight board fence, or a stone wall to break the force of the wind.

Good natural drainage of the garden area is of prime importance. The land should have sufficient fall to drain off surplus water during heavy rains, but the fall should not be so great that the soil will be washed. The surface of the garden should not contain depressions in which water will accumulate or stand. Waste water from surrounding land should not flow toward the garden, and the fall below should be such that there will be no danger of flood water backing up. The garden should not be located along the banks of a creek or stream that will be liable to overflow during the growing season.

A good fence around the garden plot is almost indispensable, and it should be a safeguard against all farm animals, including poultry, and should be close enough to keep out rabbits. A tight board fence will accomplish this result and also serve as a windbreak.—(F. B. 255.)

PLAN AND ARRANGEMENT.

The garden should be planned with a view to furnishing a large assortment and continuous supply of vegetables through the entire season. Its size will depend primarily upon the amount of land available. On the farm, where any amount of land the owner desires can be reserved for a garden, vegetables to be stored for winter as well as the summer supply, should be grown. On the village lot, space may be insufficient to grow more than the summer's supply, and it may also be necessary to leave out certain vegetables that require a large amount of space. On a city lot,

the space available for growing vegetables is necessarily small, and plantings must usually be confined to those vegetables which produce a large amount of edible product for the space occupied.

Whether the garden is on the farm, in the village, or on the city lot, the principles governing its planting and care are the same although the distances of planting, methods of tillage, and intensity of cropping may differ widely. On the farm, the saving of labor is more important than the saving of space; even the small vegetables are planted in long rows rather than in beds; and horse power is substituted for hand power wherever possible. In the village and the city, the vegetables must usually be planted as closely as the nature of their growth will permit, and hand tillage employed almost exclusively.

Much loss of time in planting a garden can be avoided by making a definite plan of the garden several weeks or even months before the planting is to begin. After measuring the area to be used for the garden, the next step is to decide what vegetables are to be grown. If space is ample, this will be determined primarily by the personal tastes of the gardener and his family. However, if only a limited amount of time and attention can be given the garden, it may be wise not to undertake the growing of some of the more exacting crops. Whatever the space to be devoted to gardening, the crops to be grown should be decided upon long before the time of planting.

In planning the garden, it is well to arrange the vegetables in the order in which they are to be planted. This facilitates the preparation of the land for planting, and makes it possible to maintain the unplanted portion in a good friable condition with the least expenditure of labor. In order that the vegetables may be so arranged, it is necessary to know the proper time for planting each crop. This depends primarily upon the temperature and moisture requirements of the particular crop in question.

If any of the small fruits, such as raspberries, currants, and gooseberries, are to be planted within the garden enclosure, they should be included with the permanent crops. The area devoted to the hotbed, cold frame, and seed bed should be decided upon, but these may be shifted more or less from year to year or located in some convenient place outside of the garden. Where there is any great variation in the composition of the soil in different parts of the garden it will be advisable to take this into consideration when arranging for the location of the various crops. If a part of the land is low and moist, such crops as celery, onions, and late cucumbers should be placed there. If part of the soil is high, warm, and dry, that is the proper location for early crops and those that need quick, warm soil.

In planning the location of the various crops in the garden, due consideration should be given to the matter of succession in order that the land may be occupied at all times. As a rule it would not be best to have a second planting of the same crop follow the first, but some such arrangement as early peas followed by celery,

or early cabbage or potatoes followed by late beans or corn, and similar combinations, are more satisfactory. In the South as many as three crops may be grown one after the other on the same land, but at the extreme north, where the season is short, but one crop can be grown, or possibly two by some such combination as early peas followed by turnips.—(F. B. 255.)

FERTILIZERS.

The kind of fertilizer employed has a marked influence upon the character and quality of the vegetables produced. For the garden only those fertilizers that have been carefully prepared should be used. Fertilizers of organic composition, such as barnyard manure, should have passed through the fermenting stage before being used. The use of night soil generally is not to be recommended, as its application, unless properly treated for the destruction of disease germs, may prove dangerous to health.

BARNYARD MANURE.

For garden crops there is no fertilizer that will compare with good, well-rotted barnyard manure. In localities where a supply of such manure can not be secured it will be necessary to depend upon commercial fertilizers, but the results are rarely so satisfactory. In selecting manure for the garden, care should be taken that it does not contain any element that will be injurious to the soil. An excess of sawdust or shavings used as bedding will have a tendency to produce sourness in the soil. Chicken, pigeon, and sheep manures rank high as fertilizers, their value being somewhat greater than ordinary barnyard manures, and almost as great as some of the lower grades of commercial fertilizers. The manure from fowls is especially adapted for dropping in the hills or rows of plants.

COMMERCIAL FERTILIZERS.

Commercial fertilizers are sold under a guaranteed analysis, and generally at a price consistent with their fertilizing value. No definite rule can be given for the kind or quantity of fertilizer to be applied, as this varies with the crop and the land. At first the only safe procedure is to use a good high-grade fertilizer at the rate of from 1,000 to 2,000 pounds to the acre and note the results. Market gardeners frequently apply as much as 2,500 pounds of high-grade fertilizer per acre each year. Farmers who do not have sufficient barnyard manure for their crops should begin gradually to use the commercial fertilizers.—(F. B. 255.)

PROFITS FROM THE USE OF FERTILIZERS.

The aim usually in the use of artificial fertilizers is to so supplement soil supplies of plant-food as to obtain a profit, and, as already intimated, the profits for the different crops will be in proportion to their economical use of the desired constituent. Still, one should not be deterred from the use of fertilizing materials, even if the conditions should render the application apparently wasteful—that is, the farmer should estimate the increase that it is necessary for him to obtain, in order to be regarded as profitable, and if only this is obtained, he should not be discouraged. Many persons seem to have gotten the impression that the use of fertilizers is a gamble

at best, and are not satisfied unless the returns from the investment in fertilizers are disproportionately large. We very often hear the statement that by the use of certain fertilizers the crop is doubled or tripled, as if this were a remarkable occurrence, and partook of the nature of a mystery. Such results are not mysterious; they can be readily explained. In an experiment on celery it is shown that the weight of celery from an application of 400 pounds per acre of nitrate of soda is two and one-half times greater than on the land upon which no nitrate was used, and that very great profit followed its use. This result is not mysterious—the nitrogen applied, if all had been used by the crop, would have given a still greater increase; it simply shows that where no extra nitrogen had been applied the plant was not able to obtain enough to make the crop what the conditions of the season and soil, in other respects, permitted. These favorable conditions, however, are not uniform, and variations in return from definite application must be expected.

It is quite possible to have a return of $50 per acre from the use of $5 worth of nitrate of soda on crops of high value, as, for example, early tomatoes, beets, cabbage, etc. This is an extraordinary return for the money invested and labor involved; still, if the value of the increased crop from its use was but $10, it should be regarded as a profitable investment, since no more land is required, and but little more capital with this return. The waste of nitrogen does not result in loss.

DANGER OF LOSS OF NITRATES BY LEACHING.

The chief difficulties in the use of nitrate of soda are due to promptness in its solubility and availability. The fact that it is so soluble carries with it the very grave danger that losses by leaching may occur if the conditions of soil and crop at the time of its application are not favorable for a rapid absorption of the nitrate by the plant. This danger is greater if it is applied to the soil before rapid growth, when there is a limited number of plants that have not made much growth, or whose roots have not taken possession of the soil, as in the case of the vegetable crops. In meadows, on the other hand, or in grain crops, where there are a large number of plants per unit of area, and in orchards or berry patches, where there are fewer plants, but a wider distribution of the feeding roots, losses are not so liable to occur. There may be, therefore, great disappointment in the returns from the use of nitrate of soda, if opinions as to its usefulness are based entirely upon its availability. Nevertheless, because no unknown conditions enter in, in reference to its availability, it is possible to avoid, in a great degree, the losses liable to occur, and thus to secure a maximum return from the application of this form of nitrogen.

THE INFLUENCE OF QUANTITY APPLIED AND METHOD OF APPLICATION.

If the quantity applied is too small to meet the demands of the crop, unless all seasonal conditions are favorable, the chances are that the results will not be completely satisfactory, as weather conditions are not likely to be perfect; it may be too wet or too dry, too

cold or too hot, and hence, during certain periods, the plants would not be able to obtain their food—that is, it would be impossible for the plant to absorb always its food uniformly, or in such amounts and at such times as would result in the best development of the plant. In all cases an amount should be applied that would exceed the needed requirement under perfect conditions.

In the second place, if the quantity found to be necessary for a definite increase of crop, under average conditions, were all applied at once, say in the early spring, a greater opportunity would be offered for losses from leaching than would be the case if the material were given in successive dressings, so that the losses due to the escape of the nitrogen would be minimized; on the other hand, if no losses occurred, the plant might take up more than could be utilized in a normal development, thus defeating the purpose, because resulting in a product of less commercial value. This would apply, of course, only in the case of those crops that are injured by abnormal development in certain directions, as, for example, too large a proportion of straw in cereal grains, too large a root in sugar beets, etc. All these difficulties may be obviated by a fractional application, or, in other words, by supplying the nitrogen at the time and in the quantity best adapted for the plant and for the purpose in view in its growth. The results from the use of nitrogen may be also unsatisfactory if nitrogen only of the elements essential is used. The best results from the use of nitrate can come only when there exist in the soil, or are applied with it, sufficient amounts of the mineral elements to enable the plant to obtain a food suited to its needs—nitrogen is but one element of plant food.—(N. J. A. E. Sta., 157.)

PREPARATION OF THE SOIL.

Where there is considerable choice in the location of the garden plot, it is often possible to select land that will require very little special preparation. On the other hand, it may be necessary to take an undesirable soil and bring it into suitable condition, and it is generally surprising to note the change that can be wrought in a single season.

Plowing.—Autumn is the time for plowing hard or stiff clay soils, especially if in a part of the country where freezing takes place, as the action of the frost during the winter will break the soil into fine particles and render it suitable for planting. Sandy loams and soils that contain a large amount of humus may be plowed in the spring, but the work should be done early in order that the soil may settle before planting. In the Southern States, where there is not sufficient frost to mellow the soil, this process must be accomplished by means of frequent cultivations, in order that the air may act upon the soil particles. It is desirable to plow the garden early, at least a few days sooner than for general field crops.

Sandy soils will bear plowing much earlier than heavy clay soils. The usual test is to squeeze together a handful, and if the soil adheres in a ball it is too wet for working. In the garden greater depth of plowing should be practiced than for ordinary farm

crops, as the roots of many of the vegetables go deeply into the soil. Subsoiling will be found advantageous in most cases, as the drainage and general movement of the soil moisture will be improved thereby.

Hand spading should be resorted to only in very small gardens or where it is desirable to prepare a small area very thoroughly.

Smoothing and Pulverizing the Soil.—After plowing, the next important step is to smooth and pulverize the soil. If the soil be well prepared before planting, the work of caring for the crops will be very materially lessened. It is not sufficient that the land be smooth and fine on top, but the pulverizing process should extend as deep as the plowing. Some gardeners prefer to thoroughly cut the land with a disk harrow before plowing, so that when it is turned by the plow the bottom soil will be fine and mellow. After the plow the disk or cutting harrow is again brought into play and the pulverizing process completed. If the soil is a trifle too dry and contains lumps, it may be necessary to use some form of roller or clod crusher to bring it down. For smoothing the surface and filling up depressions a float or drag made from planks or scantlings will be found serviceable.

TIME OF PLANTING.

No definite rule can be given regarding the time for planting seeds and plants in the garden, for the date varies with the locality and the time that it is desired to have the crop mature. A little practice will soon determine when and how often sowings should be made in order to escape frost and mature the crop at a time when it will be most useful. Certain crops will not thrive during the heated part of the summer, and their time of planting must be planned accordingly.

THE SELECTION AND PURCHASE OF GARDEN SEEDS.

In order to have a good garden it is necessary to plant good seeds. It is not alone essential that the seeds be capable of growing; they must be capable of producing a crop of the desired quality, under the conditions existing where the gardening is to be done. Some varieties of vegetables are restricted in their adaptations, while others thrive over a wide range of territory and under widely different conditions of soil and climate. If the behavior of different varieties in a given locality is not known, the safe plan to follow in selecting varieties for planting is to choose mainly those that have proved themselves adapted to a wide range of conditions and have thereby become recognized as standard sorts. The newer varieties may be tested in small quantities until their suitableness for a given place and purpose has been determined. Particular care should be taken to select varieties that are capable of yielding a product of high quality. Such varieties are numerous, and some are better for one region than another.

It is always a safe plan to have a little more seed on hand than is actually needed to plant the area desired. Sometimes the first planting of a given crop is destroyed by frost or insects, making replanting necessary. In such a case, delay in replanting could be avoided by having the seeds on hand. The additional expense is

slight compared with the value of the crop. In the case of many seeds, an ounce costs but little more than a packet; and in such cases, it is the part of wisdom to purchase an ounce, even though a packet might contain sufficient seed to barely plant the desired area. The more expensive seeds may be purchased in smaller quantities, with less margin between the actual amount required and the quantity purchased.—(U. Ill. B. 154.)

SEED SOWING.

Garden seeds should always be sown in straight rows regardless of where the planting is made. If a window box is employed for starting early plants in a dwelling, the soil should be well firmed and then laid off in straight rows about 2 inches apart. The same method holds good for planting seeds in a hotbed, cold frame, or bed in the garden, except that the rows should be farther apart than in the window box. By planting in straight rows the seedlings will be more uniform in size and shape, and thinning and cultivating will be more easily accomplished. In all cases where the soil of the seed bed is not too wet it should be well firmed or pressed down before laying off and marking for sowing the seeds. After the seeds are sown and covered, the surface should again be firmed by means of a smooth board.

No definite rule can be given for the depth to which seeds should be planted, for the depth should vary with the kind of seed and with the character and condition of the soil. In heavy clay and moist soils the covering should be lighter than in sandy or dry soils. In all cases the depth should be uniform, and when planting seeds in boxes or a bed the grooves in which the seeds are planted should be made with the edge of a thin lath.—(F. B. 255.)

Planting.—The most distinctive feature of the garden on the farm should be the reduction of hand labor to a minimum. In planting the garden, therefore, it should be laid out in long rows, sufficiently far apart to permit the use of a horse and cultivator in tending the crops. Time and confusion will also be saved if the vegetables are grouped according to their cultural requirements, and the number of plantings made as small as is consistent with the demands of the various crops. Each group of crops may then be planted and tended as one crop, and the garden operations thus greatly simplified. When more than one planting of a given crop is desired for the sake of securing a succession, the second planting may be put in at the same time that other crops are being planted, so that even in this case, the number of plantings need not be multiplied. The use of two or more varieties of the same vegetable, differing in their time of maturity, will also aid in keeping down the number of different plantings.

The arrangement of the garden as to length of rows and time of planting, is not the only labor saving feature that should characterize the typical farmer's garden. Field methods should be practiced in preparing the land for planting, and as much preliminary work done in the fall as is possible, for the sake of both securing an early garden and reducing the amount of labor in spring. After

the land is cleared of refuse from preceding crops, it should be heavily manured, and plowed in the fall. The amount of manure to be applied will depend somewhat upon the fertility of the land, but more largely upon the trueness of the farmer's conception of the plant food requirements of garden crops. The best gardens are possible only where plant is supplied much more liberally than is considered ample for field crops. Forty tons of manure per acre is a very moderate application for garden crops, and this amount should be applied annually, even on soils already rich, if maximum crops of vegetables are to be grown.

The plowing under of manure in the fall hastens the drying out of the soil in the spring, so that planting may begin earlier than if the manuring and plowing were deferred until spring. This is both because the soil actually dries out earlier, and also because no time is lost in manuring or plowing after the soil has reached workable condition. It often happens that early in the spring when the cool season crops should be planted, the soil remains in ideal condition for working only a brief period, and then becomes so thoroughly wet by copious rains that further garden work is precluded for two or three weeks. If the manuring and plowing have been done in the fall, it is often possible to plant the early vegetables in the brief period during which the soil is fit to work, while otherwise this entire period might be expended in making preparations, and the actual planting necessarily deferred until the next time the soil was dry. Since the success of many of the early crops depends upon early planting, the wisdom of fall preparation is apparent.

If the land has been manured and plowed in the fall, and is worked at the proper time in spring, very little labor is necessary in the preparation of a seed-bed for the early planting. Soil containing sufficient humus to grow vegetable crops advantageously, can be fitted for planting without the use of hand tools, if the precaution is taken to work it at the exact time it reaches the right degree of dryness. It will then crumble readily, and a seed-bed can be prepared by the use of a disk, harrow, and planker. The use of these tools saves an enormous amount of labor, and is a vast improvement over the old method of using a hoe and rake.

The actual planting of the garden is a simple matter, provided a definite plan has previously been made, so that no time is lost in deciding which vegetable to plant first, where to plant it, or how much to plant. In the home garden, only a small amount of seed of each kind is planted, so that a seed drill cannot be used to advantage, and the planting is therefore almost invariably done by hand. For the small vegetables, sown in drills, the planting involves four distinct operations: (1) making the drills, (2) dropping the seed, (3) covering, and (4) firming. The most rapid way of making the drills in a garden to be planted in long rows is to use a marker that makes three or four drills each time it is drawn across the area to be planted. With a medium weight marker, and the soil in proper condition for planting, the marks will be of the proper depth for planting seeds of any of the smaller vegetables usually

sown in drills. For peas or beans a deeper drill may be made with the plow attachment of a wheel hoe. After the seed is dropped, it is covered with a rake, or in the case of deep planting, with a hoe, or a wheel hoe. The soil is firmed over the seed by the use of the feet, the back of a hoe, or a garden roller. Whatever the means employed, the firming must be thorough, especially in light soil or dry weather; for unless the soil is brought in close contact with the seeds, they will not germinate.—(U. Ill. B. 154.)

Cultivation.—By the proper cultivation of the garden there is accomplished three things: (1) The weeds are kept out so that they do not shade or take away valuable plant food and moisture from the plants which one desires to perfect. (2) The surface soil is brought into the best condition to resist drouth; that is, into the best condition for availing itself to the utmost of the stores of water in the subsoil and to prevent the evaporation of this water from the surface soil. (3) The stores of insoluble plant food are made soluble by the chemical action and fermentation, which are increased by loosening the soil, thereby letting in the air.

Keeping Out the Weeds.—The methods best adapted for keeping the weeds out of the garden are many and varied, and depend much upon the condition and kind of soil in which the weeds grow; upon the kind of crop and upon the habits of the weeds themselves. The most important step in making easy the prevention of weeds in the garden is the harrowing or other thorough cultivation of the land just before the planting of the seed, to kill the young weeds. If this is done thoroughly, the weeds do not have a better chance than the crop. If this is not done, the weeds will be ahead of the crop in growth, and if started even ever so little when the crop is planted, the result generally is that the crop is seriously overgrown by them before it is large enough to be cultivated. *This is a common mistake, and is, perhaps, responsible for more failures in the garden than any other factor which enters into the consideration of this subject;* and it is a very simple matter to prevent any trouble from this source if a little foresight is exercised.

Early Cultivation to Kill Weeds.—The next most important factor in the prevention of weeds in the garden is early cultivation. In the case of seeds that require a long time to germinate, it is an excellent plan to lightly rake over the land with an ordinary fine-toothed rake, even before the crop appears above the ground, providing the work is so carefully done as not to disturb the seeds. When the seed is sown with a drill, the line of the row may be plainly seen even before the plants come up, thus making it easy to commence cultivating it in advance of the weeds. In case of such crops as carrots, onions, parsnips and beets, which are quite delicate when young, cultivation should begin with some hand garden cultivator, even if it is intended later on to cultivate with a horse, and the crop is planted with this purpose in view. Such close and careful work cannot be done with any horse implement now in use as with the best hand implements. With proper tools, the work may be done nearly as quickly by hand as by horse power, and far more

perfectly when the plants are small. Careful early cultivation is of the utmost importance, since, if the weeds are removed when they are young, the work of weeding is very small. If allowed to remain until well rooted, their removal is often a very serious matter, and frequently, if neglected at this early stage, the weeds become so firmly established as to make it a question whether to remove them or plow under the whole crop; and often it is the part of wisdom to adopt the latter alternative. Aside from its effect in the prevention of weeds, early cultivation is of great value in breaking up the crust that packs firmly around the tender growing stems of plants, and that seriously interferes with their growth. It is also, like all surface cultivation, of aid in the conservation of moisture in the soil.

Importance of Not Allowing Weeds to Go to Seed.—A common source of weed infection is often found in the few weeds that are allowed to go to seed toward the end of the growing season in the maturing crop or after the crop has been gathered. To some farmers it often seems a small matter to allow a few plants of pig-weed, purslane, tumble weed and weeds of other kinds to go to seed in the garden, but absolute cleanliness should be the only rule in this particular, and it is by far the most economical in practice in the long run. It requires but little labor and saves much useless expense to destroy weeds that are going to seed. If the preventives for weeds suggested are closely followed hand weeding will be reduced to a minimum and will often be unnecessary with any crop.

Weed Seeds in Manure for the Garden.—The manure applied to the garden is often coarse and contains many weed seeds, and is a fruitful source of weed infection. The manure intended for the garden that contains the seeds of weeds should be piled up and allowed to ferment until the whole mass is thoroughly rotted. By this means the seeds in it will be killed. But in order to rot manure to best advantage, it should be forked over occasionally when well warmed up by fermentation, and the whole turned over, with the outside of the pile thrown into the center. If dry, it should be watered enough to enable fermentation to continue, and to prevent "fire-fanging." It is seldom advisable to use fresh manure in the garden, and manure should only be applied in this condition when free from weeds, and then only for some late-maturing crops, in which case there will be time for it to rot before the crops need it. All early crops need well rotted manure, and require it in much larger quantities than do the late-maturing crops.—(U. Minn. A. E. S. 38.)

General Cultivation.—The methods to be pursued in the general cultivation of garden crops will vary somewhat, according to the soil, season and crop. However, it is very important to remember that the destruction of weeds is but a small part of the work of cultivation. The most important part is to so fit the soil that it may best withstand drouth. This is accomplished by frequent shallow cultivation during the period of growth. The first implements to use in the care of such crops as are generally cultivated by hand are those that work the soil to only a very slight depth, close to the

plants. Such implements may be used just as the seedlings are breaking ground. As soon as the plants have gained some little strength, implements should be used that will go deeper, until a depth of two or three inches can be easily worked without endangering the safety of the crop by covering the plants with dirt. It is doubtful if any of our garden crops should ever be cultivated more than three inches deep, and it is very certain that many crops are injured by cultivating deeply very close to the plants, in which case the roots are cut off near their upper ends and thus wholly destroyed. Cultivation in a period of drouth results in forming a mulch or blanket of dry earth on the surface of the land, which prevents the moisture from passing into the atmosphere, and a rather shallow blanket, say two inches deep, accomplishes this purpose. A compact subsoil readily transmits the water upwards to the surface soil, in the same manner that a lamp wick carries the oil to the flame. At the surface the soil water is prevented from evaporating by a blanket of loose earth, and is thus saved in the upper subsoil and lower and middle parts of the furrow slice for the roots of the crop; loose surface soil is a good non-conductor of water. During the growth of a crop, the surface of the ground should never be left long with a crust on it, but should be stirred after each rain or after artificially watering.

TOOLS.

There are a number of one-horse cultivators that are especially adapted for work in the garden. These may be provided with several sizes of teeth and shovels, and are easily transformed for various kinds of work. In working the crops while they are small the harrow or smaller teeth may be used, and later when the plants become larger the size of the shovels may be increased. Many gardeners, however, prefer to use the harrow teeth at all times. When it is desirable to ridge up the soil around a crop, the wings, or hillers, may be put on either side of the cultivator. A one-horse turning plow is useful for running off rows or throwing up ridges. Aside from the horse tools in general use on the farm, there are only one or two cultivators that will be required for the garden, and these are not expensive.

The outfit of hand tools for the garden should include a spade, a spading fork, a cut-steel rake, a 10-foot measuring pole, a line for laying off rows, a standard hoe, a narrow hoe, dibbles, a trowel, an assortment of hand weeders, a watering can, a wheelbarrow, and if the work is to be done largely by hand the outfit should also include some form of wheel hoe, of which there are a number on the market.

MULCHING.

The term mulch as generally used means a layer of litter applied to the surface of the ground primarily for the purpose of retarding evaporation from the soil. Mulches are thus used as a substitute for cultivation to conserve the moisture in the soil in summer and to keep down weeds. They are also used as winter and spring coverings for low-growing small fruits to retard flowering and fruiting and thus to protect them from injury by late frosts.

What is termed a "soil mulch" or "dust mulch" is maintained by frequent cultivation of the surface soil, and, like the ordinary mulch, is an effective means of retarding evaporation. Among the common materials used for mulching crops are straw, marsh hay, and leaves. These materials are usually applied to the whole surface of the soil in layers 4 to 6 inches deep. Mulching crops with straw or other litter is not very common. On a large scale it is too expensive. It frequently happens on a farm, however, that spring finds an old straw stack in the barnyard that will be practically valueless for feed the following winter. Can it be used profitably as a mulch?

This question was investigated quite thoroughly by the Nebraska Station. Experiments were made to determine how mulching vegetables compares with the most thorough cultivation as a general farm practice. Old straw was the material used. After settling, the layer applied was about 4 inches deep. A large number of different vegetables were grown. In general it was found that mulching in Nebraska gave much better results in normal or dry seasons than in wet seasons.

The value of the mulch in conserving the soil moisture was found to be quite marked. Soil samples taken one season in July and August showed the moisture content to a depth of 6 inches to be 18.2 per cent, as compared with 17.1 per cent in cultivated soil. When the mulch was applied early in the season before the ground became thoroughly wet, it often had a retarding effect on the growth of the vegetables. With early spring vegetables, like lettuce, which require only a few cultivations, it was found cheaper and better to cultivate than to mulch; but with longer-growing crops that require frequent cultivation throughout the season, such as cabbage, tomatoes, etc., mulching usually proved more effective and cheaper than cultivation.

The fact that most vegetables, especially the more tender kinds, can not be mulched, until they have become well established and the weather has become warm, thus requiring some preliminary cultivation, certainly increases the labor required in growing mulched vegetables over what would be necessary if the mulch could be applied earlier. But, if the impracticability of early mulching is a serious drawback to the use of mulches, so is the impracticability of midsummer cultivation under farm conditions a serious objection to dependence upon cultivation alone. For most vegetables mulching should be used to supplement cultivation rather than to displace it. Such cultivation as is commonly given farm gardens is better for most vegetables in early spring than mulching; but mulching is just as surely better in midsummer than the neglect which is the common thing in farm gardens at that time of year. The experiment station tests have indeed shown mulching to be better in many cases than the most thorough cultivation throughout the summer.

The station tests indicate that it is unwise to mulch drilled onions, lettuce, or sweet corn. The stand of the onions and lettuce is injured by mulching, while so few cultivations are required for sweet corn that mulching is hardly profitable, and in wet seasons

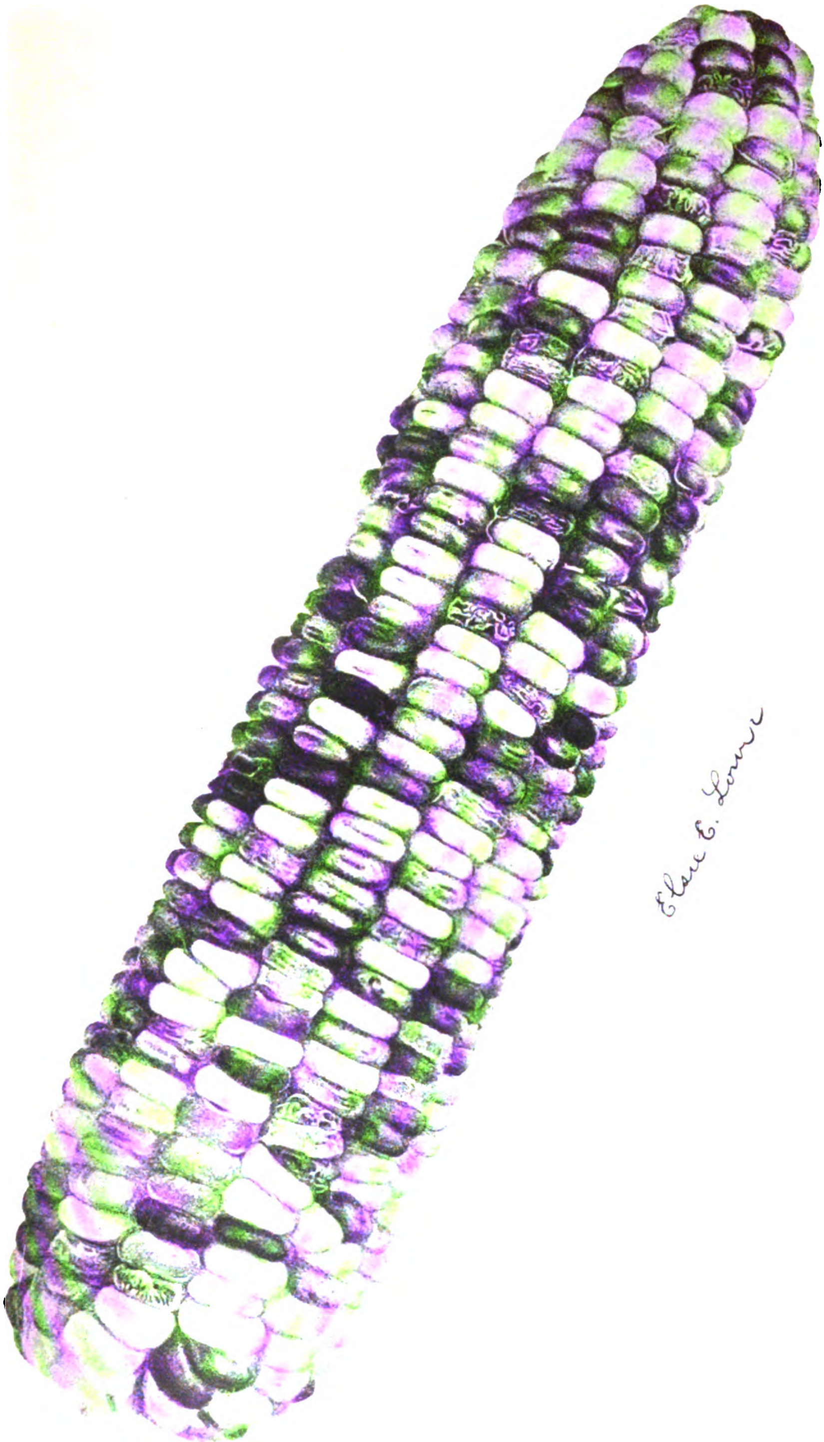
the yield was decidedly decreased by mulching. With transplanted onions, beets, salsify, parsley, peas, and melons the labor required and yield obtained were found to be about the same by either method of culture. With cabbage, tomatoes, beans, cucumbers, potatoes, and sweet potatoes, very favorable results were secured by mulching. The yields of each of these crops were considerably increased by mulching and the labor required was considerably less than in case of cultivation alone. Mulched cabbage produced larger heads than cultivated cabbage, and there was less injury from rot. The vigor of tomato plants was decreased by mulching, but the yield of fruit increased. The fruit was also cleaner and less subject to rot. Mulched cucumbers produced perfect fruits during dry periods when the fruit from the cultivated plants was small and imperfect. The quality of potatoes was not hurt by mulching except in wet places.

In a special test of a 4-inch and 8-inch straw mulch and early and late mulching for potatoes a 4-inch mulch applied late in summer after several cultivations gave the best results. In the case of sweet potatoes the vines did not take root through the straw mulch as they do on cultivated ground, which was considered a decided advantage for mulching.

On the whole this work seems to indicate that on the farm where cultivation of the garden is likely to be neglected in midsummer, a mulch of straw can be used profitably as a substitute. For the best results the mulch should not be applied until the ground has become thoroughly warmed up and after two or three cultivations have been given. The mulch may then be safely applied to such vegetables as cabbage, tomatoes, potatoes, and beans, and the garden left to take care of itself the rest of the season.

The same plans were worked at the New Jersey stations. One season it was found that mulching increased the yield of sound fruits of eggplants 66.5 per cent and of tomatoes and peppers about 13 per cent each. The keeping quality of cucumbers also appeared to be slightly benefited by the use of a mulch. The season following, which was considerably more rainy, no advantage resulted from mulching. In this experiment there was no noticeable difference in the effectiveness of new salt hay, old hay, or excelsior as a mulch.

Several of the experiment stations have carried out experiments in mulching potatoes. The favorable results obtained in such experiments in dry seasons at the Nebraska Station have already been referred to. At the Michigan Station the following yields were obtained: Mulched, 167 bushels of potatoes per acre; cultivated, 199 bushels per acre. With another variety the yield of mulched potatoes was 252 bushels, and of cultivated, 385 bushels. The cost of cultivation was less than the cost of mulching, and the profit in both instances was in favor of cultivation. It should be stated, however, that there was a large amount of rain during this season, and that the straw used as a mulch contained a considerable amount of grain, which came up on the mulched plats, both of which conditions were unfavorable to mulching.



EAR OF CORN PRODUCED BY A PLANT THAT GREW FROM A KERNEL OF BOONE COUNTY WHITE DENT THAT RESULTED FROM A POLLINATION WITH BLACK MEXICAN SWEET-CORN POLLEN. NATURALLY POLLINATED. NATURAL SIZE. (See pages 4 [illegible])

At the Oklahoma Station the total potato crop was increased about 50 per cent by mulching, the marketable crop nearly 100 per cent, and the size of the tubers about 70 per cent. Mulching potatoes with old shavings at the New Jersey stations increased the total number of tubers on a small plat about 16 per cent and the weight of the crop about 35 per cent. At the Georgia Station mulching potatoes with pine straw was not found to be of sufficient value to recommend the practice. These conflicting results secured with potatoes would seem to confirm the conclusion reached at the Nebraska Station that mulching is of greatest value in a dry season.

There is, however, a drawback to mulching that may not at first occur to the reader, viz., the danger it involves from fire. In dry weather a lighted match or cigar dropped upon the mulch may easily start a conflagration that it may be impossible to stop until the orchard is destroyed. It gives disaffected trespassers in the orchard an excellent opportunity to take vengeance upon the owner.

The cost of the mulch will of course depend much upon the price at which the material may be obtained. Clean wheat, rye, or oats straw would answer the purpose well, and in many localities would be cheaper than marsh hay. In some seasons oats sown as a second crop would grow fast enough to make mulching material by the time of frost. In the vicinity of marshes the coarser marsh grasses that have no value as hay may be cut after the ground freezes in autumn and would make excellent material for mulching. Cornstalks have been suggested, but they are probably too coarse to keep down weeds.

It has been suggested that by sowing rye in September, and harvesting the crop the following June, and then sowing the same ground to millet, the rye straw with the millet would mulch an area of plums equal to that on which the two crops were grown, and would leave the thrashed rye to compensate for the labor. This is certainly worth trying by those who have no better source from which to obtain mulching.—(Nebr. Sta. Bul., 79, 80.)

IRRIGATION.

Throughout the portions of the country where rains occur during the growing season it should not be necessary to irrigate except occasionally in order to produce the ordinary garden crops. In arid regions, where irrigation must be depended upon for the production of crops, the system best adapted for use in that particular locality should be employed in the garden. Wherever irrigation is practiced the water should not be applied until needed, and then the soil should be thoroughly soaked. After irrigation, the land should be cultivated as soon as the surface becomes sufficiently dry, and no more water should be applied until the plants begin to show the need of additional moisture. Constant or excessive watering is very detrimental in every case. Apply the water at any time of the day that is most convenient and when the plants require it.

By the subirrigation method of watering, lines of farm drain

tiles or perforated pipes are laid on a level a few inches below the surface of the soil. This system is especially adapted for use in backyard gardens where city water is available and where the area under cultivation is small. Subirrigation is expensive to install, as the lines of tiles should be about 3 feet apart, or one line for each standard row. By connecting the tiles at one end by means of a tile across the rows the water may be discharged into the tiles at one point from a hose, and will find its way to all parts of the system, entering the soil through the openings.

THINNING.

Where plants are not to be transplanted twice, but remain in the plant bed until required for setting in the garden, it may be necessary to thin them somewhat. This part of the work should be done as soon as the plants are large enough to pull, and before they begin to "draw" or become spindling from crowding.

When thinning plants in the plant bed it should be the aim to remove the centers of the thick bunches, leaving the spaces as uniform as possible. When thinning the rows of seedlings in the garden the best plants should be allowed to remain, but due consideration should be given to the matter of proper spacing. Failure to thin plants properly will invariably result in the production of an inferior crop.

There is a tendency for some gardeners to leave the plants of carrots, onions, and similar vegetables too thick, or to defer the thinning too long, with the intention of making use of the thinnings. Usually this is a serious error, except in the case of beets, which can be used quite young for greens. The crowded seedlings do not reach edible size as soon as they would if not crowded; and the removal of part of the crowded plants when they are wanted for the table is likely to seriously disturb and impair the growth of those which remain. A better plan is to make at least a preliminary thinning as early as possible, leaving the plants perhaps twice as thick as they are eventually to stand; and then to pull out every other plant after they reach edible size. This method of thinning is especially adapted to beets, carrots, lettuce and onions. The other root crops, like parsnips and salsify, should be thinned to the full distance at the first thinning.—(U. Wis. Cir. 16; F. B. 255.)

TRANSPLANTING.

At the North, where the growing season is short, it is necessary to transplant several of the garden crops in order to secure strong plants that will mature within the limits of the growing season. In the Southern States the season is longer, and transplanting, while desirable, may not be necessary, as many crops that must be started indoors at the North can be planted in the garden where they are to remain. Transplanting should be done as soon as the seedlings are large enough to handle, and again when the plants begin to crowd one another. Aside from producing more uniform and hardy plants, the transplanting process has several other very marked influences. Certain crops which are grown for their straight

roots are often injured by having their roots bent or broken in transplanting. On the other hand, such plants as celery, which at first have a straight root and are grown for their tops, are greatly benefited by transplanting. In all cases transplanting has a tendency to increase the number of small roots, and these are the main dependence of the plant at the time it is set in the open ground.

A large number of garden crops, including melons, cucumbers, and beans, do not transplant readily from the seed bed to the open ground, and some special means for handling the plants must be employed where extra early planting is desired. A common practice among gardeners is to fill pint or quart berry boxes with good soil and plant a single hill in each box.

Another method is to cut sods into pieces about 2 inches thick and 6 inches square and place them, root side upward, on the greenhouse bench or in the hotbed, the hills being planted in the loamy soil held in place by the roots of the grass. When the weather becomes sufficiently warm, and it is desired to set the plants in the garden, the berry boxes or pieces of sod are placed on a flat tray and carried to the place where the planting is to be done. Holes of sufficient size and depth are dug and the boxes or sods are simply buried at the points where it is desired to have the hills of plants. The boxes should be placed a little below the surface and fine earth worked in around the plants. If it is thought desirable, the bottoms of the boxes may be cut away when set in the garden.

SETTING IN THE OPEN GROUND.

A few hours before removing plants from the seed bed or plant bed they should be well watered and the water allowed to soak into the soil. This will insure a portion of the soil adhering to the roots and prevent the plants from wilting. If the plants have been properly thinned or transplanted it is often possible to run a knife or trowel between them, thus cutting the soil into cubes that are transferred with them to the garden. Where the soil does not adhere to the roots of the plants it is well to puddle them. In the process of puddling, a hole is dug in the earth near the plant bed, or a large pail may be used for the purpose, and a thin slime, consisting of clay, cow manure, and water, is prepared. The plants are taken in small bunches and their roots thoroughly coated with this mixture by dipping them up and down in the puddle a few times. Puddling insures a coating of moist earth over the entire root system of the plant, prevents the air from reaching the rootlets while on the way to the garden, and aids in securing direct contact between the roots and the soil.

Previous to setting out plants, the land should be worked over and put in good condition, and everything should be ready for quick operations when a suitable time arrives. The rows should be measured off, but it is well to defer making the furrows or digging the holes until ready to plant, in order to have the soil fresh. The time best suited for transferring plants from the plant bed to the open ground is when there is considerable moisture in the

air and clouds obscure the sun, and if the plants can be set before a shower there will be no difficulty in getting them to grow. During seasons when there is very little rain at planting time, or in irrigated regions, evening is the best time to set the plants. It is possible to set plants in quite dry soil, provided the roots are puddled and the earth well packed about them. When water is used in setting plants it should be applied after the hole has been partially filled, and the moist earth should then be covered with dry soil to prevent baking. Where water is available for irrigation it will be sufficient to puddle the roots and then irrigate after the plants are all in place. Plants should be set a trifle deeper in the garden than they were in the plant bed. The majority of plants require to be set upright, and where the dibble is used for planting care should be taken that the soil is well pressed around the roots and no air spaces left.

PRECAUTIONS TO AVOID ATTACKS OF INSECTS AND DISEASES.

In the control of insects and diseases that infest garden crops it is often possible to accomplish a great amount of good by careful sanitary management. In the autumn, after the crops have been harvested, or as fast as any crop is disposed of, any refuse that remains should be gathered and placed in the compost heap, or burned if diseased or infested with insects. Several of the garden insects find protection during the winter under boards and any loose material that may remain in the garden. Dead vines or leaves of plants are frequently covered with spores of diseases that affect those crops during the growing season, and these should be burned, as they possess very little fertilizing value.

PROTECTION OF PLANTS.

Some plants require protection from the direct rays of the sun in summer or from cold in winter, and there are many that need special protection while they are quite small. Seedlings of many of the garden crops are unable to force their way through the crust formed on the soil after heavy rains, and it is necessary either to break the crust with a steel rake or soften it by watering.

In parts of the country where the sunshine is extremely hot during a part of the summer, some plants, especially those that are grown for salad purposes, are benefited by shading. Shading is often used in the care of small plants when they are first transplanted.

Where boards are available they can be used for protecting plants that have been set in rows in the garden by placing them on the south side of the row at an angle that will cast a shadow over the plants, and holding them in place by short stakes driven in the ground. Laths, wooden slats, cotton cloth, or shaded sash are frequently used to protect plant beds from the heat of summer.

For protecting plants from cold in winter several kinds of materials are used, such as boards, cloth, pine boughs, straw, manure, or leaves. There are a number of crops of a tropical nature that may be grown far north, provided they are properly protected during the winter.

Several of the annual crops can be matured much earlier in the spring if they are planted in the autumn and protected during the winter. Plants of this kind can often be protected by means of boards set at an angle on the north side of the row instead of on the south. A mulch of manure, straw, or leaves forms a good protection, but care should be taken that the mulch does not contain seeds of any kind or serious trouble will attend the further cultivation of the crop. Plants are like animals in that they require air, and care should be exercised in putting on the winter covering not to smother them. Coarse, loose materials are better for a winter covering than fine, easily compacted substances.—(F. B. 255.)

HARVESTING, PACKING AND SHIPPING.

As a rule the crop should be harvested just before it reaches maturity. The time for this depends somewhat upon the distance from the market and the method of shipment. Remember that it costs just as much freight for a package of poor goods as for the best, and while there is a market for good produce, poor stuff not only does not bring good prices, but reacts upon the superior article, reducing its price. It is, therefore, poor policy to ship inferior goods. Inspect and assort rigorously, retaining all doubtful product for canning, or to be otherwise disposed of. Better lose it entirely than send it to market to undermine the good. Learn what kind of package the market you are selling in prefers. Provide that package, and pack the goods securely and honestly. Be sure the package is full. Not only is this more honest, but your produce will arrive upon the market in better condition if this is done. Have the goods in each package as near the same size as possible, and as near the same degree of ripeness. Do not make the error of placing the best on top. Remember that every package is examined by the buyer until he learns whether you are honest or not, and this practice fools no one, and only serves to make the buyer wary of your goods. Pack neatly in a neat clean package. Nail it up securely, stencil your name and post office, and the name of the consignee upon it, and ship as promptly, and by the most direct route possible. Notify the consignee promptly of the shipment in order that he may know it is on the way, and have a chance to provide for its reception and disposal. The shipment of perishable goods by freight in refrigerator cars is preferable. Very early in the season ventilated cars may give satisfaction. Except with a few packages of very early vegetables or fruits, express shipments will not, as a rule, be found profitable. Not only will the charges be four or five fold, but the packages are handled so often, and so roughly, that they invariably reach their destination in poor condition. Besides this, there is no assurance as to the temperature being kept low, and a low temperature, while in transit, is essential to the arrival of your produce upon the market in good condition.

Careful selection, packing and shipping cannot be too strongly urged. Upon the intelligence and care with which this is done, depends, largely, the success of the shipper. Remember that after leaving your hands, and before reaching the consumer, these perish-

able goods are subjected to their greatest ordeal, and too much care cannot be given to make this test as light as possible. A proper understanding of this by the shipper would save many a disappointment, and many a hard word for the consignee. Of course, all else being equal, it is much safer and more satisfactory to sell on the track. However, this is not always possible, nor is it always advisable when possible. It would be unjust to demand or to expect the buyer to pay you the net price of the big city market for your goods at your home town.

In buying from you there, he takes the risk of transportation, of the fluctuations of the market, and pays all selling charges, and it is but just and right that he should be allowed a fair margin for these risks. On the other hand, human nature is the same the world over, and unless you watch Mr. Buyer closely, you will find he shows a decided tendency to make this margin unnecessarily large. To sell on track, intelligently and advantageously, therefore, you must make a close study of the market conditions. It is not enough to know what stuff sold for last week. You should know what it sold for the day before, and what the conditions of supply and demand are. Is the crop a large one? Is the movement to your market large or light? Is the demand brisk or dull? Is your railroad service efficient? All these questions should be considered, and unless the farmer recognizes that the disposal of his crop is a business, and adopts business methods, he is sure to come to grief. In order to do this, it is necessary to have some reliable source of information. For this purpose, select some reliable commission house, and if necessary, pay them to furnish you daily market reports by wire during the shipping season. Do not begrudge the little money these telegrams will cost, for they will frequently save you many a dollar, even on one carload.—(La. St. U. & A. & M. Col. 81.)

CANNING VEGETABLES IN THE HOME.

One of the many problems that confront the American housewife is the supply of vegetables for her table during the winter months. "What can I have for dinner today?" is a question often heard. Since the advent of the modern greenhouse and the forcing of vegetables under glass, fresh vegetables can usually be found at any time in the markets of the large cities. But the cost of forcing vegetables or growing them out of season is and will continue to be very great. This makes the price so high as almost to prohibit their use by people of moderate means, except as a luxury. A healthful diet, however, must include vegetables, and therefore the housewife turns to canned goods as the only alternative. These are sometimes poor substitutes for the fresh article, especially the cheaper commercial grades, which necessarily lack the delicate flavor of the fresh vegetable. There is practically no danger, however, from contamination with tin or other metals providing the containers are made of proper materials and handled carefully. In some cases the proper care is not taken in packing vegetables for market. The decayed and refuse portions are not so carefully removed as they should be and

the requisite degree of cleanliness is not observed in their packing. Happily, however, such carelessness is not general.

Every housewife may run a miniature canning factory in her own kitchen, and on the farm this is especially economical and desirable, the economy being less pronounced in the case of city dwellers, who must buy their fruits and vegetables. Enough vegetables annually go to waste from the average farm garden to supply the table during the entire winter. But usually the farmer's wife cans her tomatoes, preserves her fruits, and leaves her most wholesome and nutritious vegetables to decay in the field, under the impression that it is impossible to keep them. This is a great mistake. It is just as easy to keep corn or string beans as it is to keep tomatoes, if you know how.

Sterilization.—The great secret of canning or preserving lies in complete sterilization. The air we breathe, the water we drink, all fruits and vegetables, are teeming with minute forms of life which we call bacteria, or molds, or germs. These germs are practically the sole cause of decomposition or rotting. The exclusion of air from canned articles, which was formerly supposed to be so important, is unnecessary provided the air is sterile or free from germs. The exclusion of air is necessary only because in excluding it we exclude the germ. In other words, air which has been sterilized or freed from germs by heat or mechanical means can be passed continuously over canned articles without affecting them in the least. If a glass bottle is filled with some vegetable which ordinarily spoils very rapidly—for instance, string beans—and, instead of a cork, it is stoppered with a thick plug of raw cotton and heated until all germ life is destroyed, the beans will keep indefinitely. The air can readily pass in and out of the bottle through the plug of cotton, while the germs from the outside air cannot pass through, but are caught and held in its meshes. This shows that the germs and their spores or seeds are the only causes of spoilage that we have to deal with in canning.

Germs which cause decay may be divided into three classes—yeasts, molds and bacteria. All three of these are themselves plants of a very low order, and all attack other plants of a higher order in somewhat the same way. Every housewife is familiar with the yeast plant and its habits. It thrives in substances containing sugar, which it decomposes or breaks up into carbonic acid and alcohol. This fact is made use of in breadmaking, as well as in the manufacture of distilled spirits. Yeasts are easily killed, so they can be left out of consideration in canning vegetables. Molds, like yeasts, thrive in mixtures containing sugar, as well as in acid vegetables, such as the tomato, where neither yeasts nor bacteria readily grow. Although more resistant to heat than yeasts, they are usually killed at the temperature of boiling water. As a general rule, molds are likely to attack jellies and preserves and are not concerned with the spoiling of canned vegetables. The spoiling of vegetables is due primarily to bacteria.

The reproduction of bacteria is brought about by one of two

processes. The germ either divides itself into two parts, making two bacteria where one existed before, or else reproduces itself by means of spores. These spores may be compared with seeds of an ordinary plant, and they present the chief difficulty in canning vegetables. While the parent bacteria may be readily killed at the temperature of boiling water, the seeds retain their vitality for a long time even at that temperature, and upon cooling will germinate, and the newly formed bacteria will begin their destructive work. Therefore it is necessary, in order to completely sterilize a vegetable, to heat it to the boiling point of water and keep it at that temperature for about one hour, upon two or three successive days, or else keep it at the temperature of boiling water for a long period of time—about five hours. The process of boiling upon successive days is the one that is always employed in scientific work and is much to be preferred. The boiling on the first day kills all the molds and practically all of the bacteria, but does not kill the spores or seeds.

As soon as the jar cools these seeds germinate and a fresh crop of bacteria begin work upon the vegetables. The boiling upon the second day kills this crop of bacteria before they have had time to develop spores. The boiling upon the third day is not always necessary, but is advisable in order to be sure that the sterilization is complete. Among scientists this is called fractional sterilization, and this principle constitutes the whole secret of canning. If the housewife will only bear this in mind she will be able with a little ingenuity to can any meat, fruit, or vegetable.

Exclusion of the Air.—Even after sterilization is complete the work is not yet done. The spores of bacteria are so light that they float about in the air and settle upon almost everything. The air is alive with them. A bubble of air no larger than a pea may contain hundreds of them. Therefore it is necessary after sterilizing a jar of vegetables to exclude carefully all outside air. If one bacterium or one of its spores should get in and find a resting place, in the course of a few days the contents of the jar would spoil. This is why the exclusion of air is an important factor, not because the air itself does any damage but because of the ever-present bacteria.

All of this may seem new fashioned and unnecessary to some housekeepers. Persons have quite often heard it said: "My grandmother never did this, and she was the most successful woman at canning that I ever knew." Possibly so, but it must be remembered that grandmother made her preserves—delicious they were, too—and canned her tomatoes, but did not attempt to keep the most nutritious and most delicately flavored vegetables, such as lima beans, string beans, okra, asparagus, or even corn.

So-Called "Preserving Powders."—There are a great many brands of so-called "preserving powders" on the market. These are sold not only under advertised trade names but by druggists and peddlers everywhere. In the directions for use the housewife is told to fill the jar with the fruit or vegetable to be canned, to cover with water, and to add a teaspoonful of the powder. It is true that these powders may prevent the decay of the fruit or vegetable, but they

also encourage uncleanly, careless work, and in the hands of inexperienced persons may be dangerous. While with small doses the influence may not be apparent in an adult in normal health, with a child or an invalid the effect may be of a serious nature. The proper way to sterilize is by means of heat, and as this can be done very easily and cheaply the use of chemical preservatives in canning is not to be recommended.

Kinds of Jars.—The first requisite for successful canning is a good jar. Glass is the most satisfactory. Tin is more or less soluble in the juices of fruits and vegetables. Even the most improved styles of tin cans which are lacquered on the inside to prevent the juice from coming in contact with the tin are open to this objection. While the amount of tin dissolved under these conditions is very small, enough does come through the lacquer and into the contents of the can to be detected in an ordinary analysis. While the small amount of tin may not be injurious, it gives an undesirable color to many canned articles. Tin cans can not readily be used a second time, while glass with proper care will last indefinitely.

There are a great many kinds of glass jars on the market, many of them possessing certain distinct points of advantage. The ordinary screw-top jar is the one in most common use. Although cheap in price, these jars are the most expensive in the long run. The tops last only a few years and, being cheaply made, the breakage is usually greater than that of a better grade of jar. The tops also furnish an excellent hiding place for germs, which makes sterilization very difficult.

The most satisfactory jar is the one which has a rubber ring and glass top, held in place by a simple wire spring. There are several brands of these jars on the market, so no difficulty should be experienced in obtaining them. Vegetables often spoil after being sterilized because of defective rubbers. It is poor economy to buy cheap rubbers or to use them a second time. As a general rule black rubbers are more durable than white ones.

Buy a good grade of jar. The best quality usually retails at from a dollar to a dollar and twenty-five cents a dozen. The initial expense may be, therefore, somewhat high, but with proper care they should last many years. The annual breakage should be less than 3 per cent on the average. In selecting a jar always give preference to those havings wide mouths. In canning whole fruit or vegetables and in cleaning the jars the wide mouth will be found to be decidedly preferable.

Containers for Sterilizing.—A tin clothes boiler with a false bottom made of wire netting cut to fit may be used as a container for sterilizing. The netting is made of medium-sized galvanized wire (No. 16) with one-half inch mesh. A false bottom is absolutely necessary, as the jars will break if set flat upon the bottom of the boiler. Narrow strips of wood, straw, or almost anything of this nature may be used for the purpose, but the wire gauze is clean and convenient.

There are several varieties of patent steamers or steam cookers in common use. These have either one or two doors and hold a dozen or more quart jars. They are ideal for canning, but they are somewhat expensive and can be easily dispensed with. A common ham boiler or clothes boiler with a tight-fitting cover will answer every purpose.—(F. B. 359.)

Selection and Preparation of Vegetables.—The first step in successful canning is the selection and preparation of the vegetables. Never attempt to can any vegetable that has matured and commenced to harden or one that has begun to decay. As a general rule, young vegetables are superior in flavor and texture to the more mature ones. This is especially true of string beans, okra, and asparagus. Vegetables are better if gathered in the early morning while the dew is still on them. If it is impossible to can them immediately, do not allow them to wither, but put them in cold water, or in a cold, damp place and keep them crisp until you are ready for them. Do your canning in a well-swept and well-dusted room. This will tend to reduce the number of spores floating about and lessen the chances of inoculation.

STORING.

The assortment of vegetables which can be made available for winter use is much larger than is ordinarily supposed. No less than thirty distinct kinds of vegetables can be preserved for winter use by proper methods of storing, canning, and pickling. Of these, at least twenty may be kept in the fresh state, without canning or pickling. Besides the staple crop, potatoes, the list includes the root crops (beets, carrots, horse-radish, parsnips, winter radish, rutabaga, salsify, turnips), kohl-rabi, cabbage, celery, leeks, chicory, parsley, onions, dry beans, pumpkins, squashes and sweet potatoes. The vegetables most commonly canned are rhubarb, tomatoes, corn, peas and string beans; those commonly preserved by pickling are cauliflower, cucumbers (both green and ripe), citron, green peppers and green tomatoes.

When vegetables are to be canned or pickled, it is not usually necessary to grow them especially for that purpose, except to make sure that a suitable variety is planted in sufficient quantity. When the vegetables have reached the right stage of maturity and the supply is abundant, part of the crop is simply canned or pickled without special regard to the particular time in the season it may be done. However, with vegetables to be preserved in the fresh state for winter use it is essential that they be planted at such a time that they will reach the right stage of development at the proper season for storing. This means that in the case of some of the crops they will be planted considerably later than if designed for summer use, since the product is of better quality if not allowed to continue growth after reaching the desired stage of development, and this stage should not be reached before the arrival of the storage season. Since most vegetables usually keep best if put into storage comparatively late, it should be the aim of the gardener to mature the vegetables for

winter use as late in the season as he can, and yet have them harvested before they are injured by cold.

Of the vegetables stored for winter, some require entirely different conditions in storage than do others, so that attempts to store all vegetables under the same conditions would result only in failure. In order that the root crops may be stored without wilting, rotting or starting into growth, they must be kept cool, fairly moist, and away from contact with circulating air. Cabbage may be successfully stored under the same conditions. Onions must be kept at a low temperature, but differ from the root crops in that they must be in a dry atmosphere and have free circulation of air. In a moist atmosphere, under high temperature, they would either rot or sprout. Vegetables that are expected to continue growth while in storage, such as celery, leeks, Brussels sprouts, chicory and parsley, must be planted in dirt and the roots kept moist. Air should circulate freely about the tops, and the temperature must be low. On the other hand, sweet potatoes, pumpkins and squashes demand a high temperature and dry atmosphere, with free circulation of air.

The conditions of storage favorable to the different crops are secured in various ways. Market gardeners use outdoor pits or specially constructed cellars for their root crops, cabbage and celery. Onions are commercially stored in slatted crates piled in tiers in frost-proof houses provided with means for ventilation so that the temperature can be maintained at slightly above freezing. Sweet potatoes and squashes are also stored in specially constructed houses, in which the temperature can be controlled; but since a high temperature is demanded for these crops, artificial heat is usually employed. Circulation of air about these products in storage is facilitated by the use of slatted bins, and allowing ample space between the bins and the side walls of the building.

For home use the root crops and cabbage can best be stored in outdoor pits for late winter use, and in the cellar for use early in the season. The chief objection usually urged against storing root crops in the cellar is that they are likely to wilt. This difficulty can be obviated by packing the roots in boxes with alternate layers of earth or sand, and placing the boxes in the coolest part of the cellar. The earth will absorb any odors in case the vegetables should start to decay, and thus avoid endangering the health of the family. Cabbage can be stored in the same way if the roots and outer leaves are removed and merely the heads are packed in boxes or barrels of earth.

Cabbage intended for late winter use, however, will keep better in an outdoor pit than in a cellar. The same is true of parsnips, salsify, horse-radish and some of the other root crops. Except where the ground is especially well drained, the pits are usually made entirely above ground. For storing cabbage in this manner, the plants are pulled with the roots and leaves on, and placed upside-down in regular order on a level piece of ground. Usually three plants are placed side by side, with two above, and this arrangement repeated so that the final result is a long, low pile of cabbage

showing five plants in a cross section. Earth is piled against and over this array of cabbage until the plants, including the roots, are entirely covered. In a severe climate, a layer of manure may be added when cold weather arrives.

For storing parsnips, salsify and horse-radish, which are uninjured by freezing, the roots may be placed in a pile on the ground and covered with about six inches of earth. The advantage of storing in this manner, instead of allowing the roots to remain where they grew, is the saving in time of digging, when a few roots are wanted during the winter. It is much easier to open the pit when the ground is frozen than to dig roots from the garden with a pick. In fact, the difficulty of digging almost precludes the use of these crops in midwinter unless they are more accessible than in the place where they grew.

Beets, carrots, turnips, rutabagas, kohl-rabi and Irish potatoes can also be stored in outdoor pits, but they must be covered sufficiently to prevent freezing. One of the best ways of handling these crops is to place them in a conical pile and cover first with six or eight inches of hay or straw, then with earth to a similar depth. If extremely cold weather is expected, a layer of manure should be placed outside of the earth. In getting vegetables from pits of this kind in midwinter, the manure is removed slightly from one side of the pit near the bottom and a hole about a foot square chopped through the frozen earth with an old ax. Sufficient hay is then pulled out by means of an iron hook, to enable a person to thrust his arm into the opening and reach the vegetables.—(U. Ill. 154.)

EARLY PLANTS IN HOTBEDS.

The most common method of starting early plants in the North is by means of a hotbed. The hotbed consists of an inclosure covered with sash and supplied with some form of heat, usually fermenting stable manure, to keep the plants warm and in a growing condition. As a rule, the hotbed should not be placed within the garden inclosure, but near some frequently used path or building where it can receive attention without interfering with other work. The hotbed should always face to the south, and the south side of either a dwelling, barn, tight board fence, hedge, or anything affording a similar protection, will furnish a good location. The hotbed should be started in February or early in March, in order that such plants as the tomato and early cabbage may be well grown in time to plant in the open ground. There are two or three forms of hotbeds that are worthy of use.

A temporary hotbed, such as would ordinarily be employed on the farm, is easily constructed by the use of manure from the horse stable as a means of furnishing the heat. Select a well-drained location, where the bed will be sheltered, shake out the manure into a broad, flat heap, and thoroughly compact it by tramping. The manure heap should be 8 or 9 feet wide, 18 to 24 inches deep when compacted, and of any desired length, according to the number of sash to be employed. The manure for hotbed purposes should contain sufficient litter, such as leaves or straw, to prevent its packing

soggy, and should spring slightly when trodden upon. After the manure has been properly tramped and leveled, the frames to support the sash are placed in position facing toward the south. These frames are generally made to carry 4 standard hotbed sash, and the front board should be 4 to 6 inches lower than the back, in order that water will drain from the glass. Three to five inches of good garden loam or specially prepared soil is spread evenly over the area inclosed by the frame, the sash put on, and the bed allowed to heat. At first the temperature of the bed will run quite high, but no seeds should be planted until the soil temperature falls to 80° F., which will be in about three days. In most farmhouses enough heat is wasted throughout the winter to sustain a small hothouse to say nothing of a hotbed.

Hotbeds having more or less permanence may be so constructed as to be heated either with fermenting manure, a stove, a brick flue, or by means of radiating pipes supplied with steam or hot water from a dwelling or other heating plant. For a permanent bed in which fermenting manure is to supply the heat, a pit 24 to 30 inches in depth should be provided. The sides and ends of the pit may be supported by brick walls or by a lining of 2-inch plank held in place by stakes.

Standard hotbed sash are 3 by 6 feet in size, and are usually constructed of white pine or cypress. As a rule, hotbed sash can be purchased cheaper than they can be made locally, and are on sale by seedsmen and dealers in garden supplies. In the colder parts of the country, in addition to glazed sash either board shutters, straw mats, burlap, or old carpet will be required as a covering during cold nights. It is also desirable to have a supply of straw or loose manure on hand to throw over the bed in case of extremely cold weather.

During bright days the hotbed will heat very quickly from the sunshine on the glass and it will be necessary to ventilate during the early morning by slightly raising the sash on the opposite side from the wind. Care should be taken in ventilating to protect the plants from a draft of cold air. Toward evening the sash should be closed in order that the bed may become sufficiently warm before nightfall. Hotbeds should be watered on bright days and in the morning only. Watering in the evening or on cloudy days will have a tendency to chill the bed and increase the danger from freezing. After watering, the bed should be well ventilated to dry the foliage of the plants and the surface of the soil and prevent the plants being lost by damping-off fungus or mildew.

HANDLING OF PLANTS.

Successful transplanting of indoor-grown plants to the garden or field depends largely upon their proper treatment during the two weeks preceding the time of their removal. Spindling and tender plants will not withstand the exposure of the open ground so well as sturdy, well-grown plants, such as may be secured by proper handling.

Plants grown in a house, hotbed, or cold frame will require to

be hardened off before planting in the garden. By the process of hardening off, the plants are gradually acclimated to the effects of the sun and wind so that they will stand transplanting to the open ground. Hardening off is usually accomplished by ventilating freely and by reducing the amount of water applied to the plant bed. The plant bed should not become so dry that the plants will wilt or be seriously checked in their growth. After a few days it will be possible to leave the plants uncovered during the entire day and on mild nights. By the time the plants are required for setting in the garden they should be thoroughly acclimated to outdoor conditions and can be transplanted with but few losses.—(F. B. 255; U. Mo. Col. Ag. & Mech. Arts 33; N. La. 81; Kan. St. Ag. Col. 70; S. Dak. 47; U. Idaho 17.)

FRAMES USED IN TRUCK GROWING.

Intensive gardening under sash or cloth covers has become one of the most popular and, in certain localities where the conditions are suitable, one of the most profitable lines of outdoor work. The trucker and the market gardener of the present day have been compelled by keen competition and a constantly increasing demand for high-grade products out of season to provide special facilities for increasing and improving the product, as well as to take advantage of every favorable natural condition. Many localities are especially favored with an abundance of sunshine at all seasons of the year, and at the same time their climate, due to the influence of large streams or near-by bodies of water, is mild and free from extremes of temperature. In such localities it would be possible to grow lettuce, radishes, and similar crops during the entire winter without protection were it not for a few cold days and nights. A very slight covering or the application of a small amount of heat will, as a rule, carry the plants through in good condition. This industry may readily be combined with regular truck farming, as it furnishes remunerative employment during the winter months. A comparatively small area is necessary for the frames, but several times that acreage of land should be available, so that the site of the frames may be changed every few years to safeguard against diseases and insect injuries.

Cloth-Covered Frames.—The type of frame or bed varies with the different localities and is ordinarily no more elaborate or expensive than is necessary to protect the crops. In North Carolina and South Carolina the type of frame generally used is that having for the sides two lines of 12-inch boards set on edge and held in place by means of stakes driven into the ground. The covering of cheap unbleached muslin is supported on strips of wood 1 inch thick and 2½ or 3 inches wide, which are raised in the center by being carried over the top of a stake; the ends are held down by nailing to the sides of the bed. Most of these frames are temporary and are taken apart and stored during the summer months. Before placing the frames in position in the autumn the soil is plowed, thoroughly fitted, and given a liberal dressing of well-rotted stable manure and commercial fertilizers. The placing of the boards will cause some trampling of the bed, and before putting in the ends and nailing on

the rafters or strips to support the cloth it is desirable to loosen the soil again by means of a harrow or cultivator. The stakes for supporting the cross strips or rafters are then driven through the center and the strips nailed in place at intervals of 4 feet. The ends are inclosed by means of 12-inch boards, and the bed is then ready for the cloth cover. The cloth is first stitched, with the strips running lengthwise of the bed, into one great sheet large enough to cover the entire bed. This sheet is fastened on the north side of the frame by nailing over it plastering laths or similar strips of wood. The cloth should not be fastened to the top edge of the board but on the side, 1 or 2 inches below the top. For fastening the sheet on the south side of the frame short loops of string or cloth are attached to its edge and these are looped over nails driven into the side of the bed.

Sash-Covered Frames.—In the tidewater region of Virginia the frames are covered with hotbed sash. The climate of Norfolk is a little too severe for the use of cloth except for early autumn and spring crops. A number of growers in the vicinity of Norfolk handle sash-covered frames occupying as much as 3, 4, or 5 acres each season. For the sides and ends of these frames the same class of cheap lumber as for the cloth-covered frames is used.

Heated Frames.—Farther north, near Chicago, St. Louis, Cleveland, Detroit, Baltimore, Philadelphia, Cincinnati, New York, and Boston, sash-covered frames are extensively used for growing early vegetables. This work is practically the same as that found at Norfolk, except that the frames are constructed over an excavation which is filled with fermenting manure to provide heat. Where manure-heated beds are extensively used for growing early vegetables a long, shallow pit is opened, the manure is trodden in, and 12-inch boards are fastened to stakes to form the sides. The board on the north side is raised a little higher than the one on the south side in order to form a slope for the glass. A few strips are nailed across the bed to prevent the sides from coming in by the pressure of the manure or soil that is banked on the outside, and the sash simply rest on the sides without any guide or supporting strips between them. Straw mats and board shutters are employed as a protection for the sash during cold weather.

Temperature of Frames.—The temperature at which the air of the beds should be carried will depend entirely upon the crop being grown. Thermometers should be placed at intervals in the beds, as it is not safe to judge the temperature by personal sensation. If lettuce, parsley, or radishes are growing in the beds, the temperature should not go above 70° F. before ventilation is given; on the other hand, if the frames are filled with cucumbers, eggplant, or peppers, the temperature may run 8 or 10 degrees higher. It should be borne in mind that any covering, whether cloth or sash, will exclude a part of the light, and every precaution is necessary to prevent the plants becoming "drawn." The safest plan is to keep the temperature a trifle low and thus retain the plants in a strong, thrifty condition. Where tender plants are being grown under cloth there is

greater danger of injury from keeping them covered too tightly than from exposure to moderate cold.

VENTILATION.

Open-Air.—In the care of cloth-covered frames the covers are left off during bright weather and the plants subjected to open-air conditions. When there is danger of cold the covers are put on at night, and during unfavorable weather they are frequently left on during the day. While the cloth covers conserve the heat, they at the same time exclude the sunlight, and if they are kept on too great a portion of the time the crops will become drawn and spindling. With sash-covered frames the matter of ventilation is of prime importance. The glass admits and holds the heat of the sun's rays, and during bright weather it is necessary to open the frames quite early in the morning. Ventilation is accomplished by propping up one end or one side of the sash on a notched stick. The rule to be followed is to ventilate on the side away from the wind, so that the wind will blow over the opening and not into the bed.

Protection of Frames.—The area occupied by the frames is often surrounded by a high board fence or a hedge of evergreens to break the force of the wind. If a large area is devoted to frames it is sometimes subdivided by numerous cross fences to break up air currents and lessen the force of storms. Where no heat is applied to the frames the control over temperature will not be great except in the prevention of too high temperature by means of ventilation during bright weather. In many instances straw and burlap mats are kept ready at hand for throwing over sash-covered frames to prevent loss from freezing, but this would not be practicable on a large scale. Sometimes the glass is covered by shoveling one-half or three-fourths of an inch of soil over it, but this involves considerable labor and frequently results in the breakage of a great deal of glass. It is possible to ward off frost by the use of a number of orchard heaters in the frame yard. These heaters burn kerosene or crude oil and give off both heat and a smudge which will prevent injury from a reasonable degree of cold.

Crops Grown in Frames.—The crops most commonly grown in frames are lettuce, radishes, cucumbers, garden beets, parsley, eggplant, peppers, and snap beans. The crops grown in the sash-covered frames do not differ materially from those grown under cloth. In the spring, however, many growers devote their beds almost entirely to cucumbers and eggplant instead of to lettuce and radishes. To the southward the cloth covers are sufficient to protect the more hardy crops throughout the winter. To the northward the hardy crops may be grown under sash in midwinter, and those requiring more heat are grown in the spring.

Marketing Crops Grown in Frames.—Crops grown in frames are usually superior in quality and appearance to those grown in the open and should be given more care in handling and marketing. The cost of production is somewhat higher than for outdoor crops, and it is essential that they be put up in neat packages in order to bring the highest market price. The more successful growers give

CARRIE GOOSEBERRY.

the work of gathering, grading, and packing the crop their closest personal attention and use only clean, attractive packages for handling and shipping.

The packages employed for handling the frame products are generally the same as those used for marketing outdoor vegetables, of the same kinds. In a few instances a distinctive package has been employed. The use of special shipping packages that would give the frame-grown produce special recognition on the markets would be a decided advantage to the grower.—(F. B. 460.)

SOIL AND FERTILIZERS.

The greater portion of the work with frames is conducted on light or sandy loam soils which are naturally well drained and adapted to intensive trucking. The original soil is usually employed, but when necessary rich soil is hauled and placed in the beds. The first essential is good drainage, and if the land is not naturally well drained it should be tiled or provided with numerous open ditches to carry off the water. The surface of the soil should be graded and all depressions filled in and leveled. For best results the land should be subjected to two or three years of preparation by manuring and planting to leguminous crops.

The presence of plenty of organic matter in the soil is very important, especially where large quantities of commercial fertilizers are to be used. This organic matter may be added in the form of stable manure, but more satisfactory results will be obtained where leguminous crops are included in the preparatory treatment. For green manure nothing is better than cowpeas as a summer crop and crimson clover as a winter crop. The crimson clover should be turned under about the time it comes into full bloom in the spring, the land planted to cowpeas, and the resulting crop plowed under or mowed for hay during the month of August in ample time to prepare the land for frame work during the autumn. When heavy crops of green manure are turned under it is essential that lime be used to improve the mechanical condition and to sweeten the soil; a dressing of 1,000 pounds to the acre should be sufficient.

Large quantities of stable manure are used in growing crops in frames, sometimes as much as 30 to 60 cartloads to the acre. The manure is generally spread in a broad, flat pile to compost before it is applied to the soil on which frames are to be located. Where manure is employed for heating the beds it may afterwards be mixed with the soil for the growing of subsequent crops. Poultry and sheep manure is excellent fertilizer for frame work, but the quantity obtainable is very small. In the application of natural manures of all kinds it is essential that the manure should be fine; that it be what is termed "short" manure.

WATERING CROPS.

To insure success in the cultivation of plants in frames it is necessary to provide some means of applying water to the soil. Occasionally the supply of water can be obtained from the system of some city, but more often it must be pumped from a well or stream and stored for use in an elevated tank. Watering is gen-

erally done during the late afternoon, but should be completed early enough to permit the foliage to become reasonably dry before closing the frames for the night. If the plants are young and very tender it will be important to avoid too great a degree of moisture. Serious losses from "damping-off" often result from excessive moisture, especially at night, when evaporation is not so rapid as during the day. Many gardeners make the mistake of watering too often and not doing the work thoroughly. Under ordinary conditions twice a week will be often enough to apply water, and in winter, when evaporation is at its lowest point, once a week will be sufficient. In watering the sash-covered frames it is necessary either to remove the sash or to prop them up high enough to permit working under them. As a rule the sash are taken off early in the morning of a bright day, the soil is stirred, sometimes a little fertilizer is added, later in the day the bed is watered, and toward night the sash are replaced.

ANISE.

This is an annual. Leaves used as a garnish. The seeds are the source of Anise oil. This plant grows well and gives a good yield of seed. Seeds should be soaked over night in warm water and sown thickly.—(U. Idaho 10.)

ARTICHOKE, GLOBE.

This plant requires a deep, rich sandy loam, with a liberal supply of well-rotted manure, is best suited for growing artichokes. Plant the seeds as soon as the soil is warm in the spring, and when the plants have formed three or four leaves they may be transplanted to rows 3 feet apart and 2 feet apart in the row. The plants do not produce until the second season, and in cold localities some form of covering will be necessary during the winter. This crop is not suited for cultivation north of the line of zero temperature. After the bed is once established the plants may be reset each year by using the side shoots from the base of the old plants. If not reset the bed will continue to produce for several years, but the burs will not be so large as from new plants. The bur, or flower bud, is the part used, and the burs should be gathered before the blossom part appears. If they are removed and no seed is allowed to form, the plants will continue to produce until the end of the season.

ARTICHOKE, JERUSALEM.

This useful and productive plant will grow in any good garden soil, and should be planted three to four feet apart each way, with three or four small tubers in a hill. If large tubers are used for planting they should be cut the same as Irish potatoes. Plant as soon as the ground becomes warm in the spring and cultivate as for corn. A pint of tubers cut to eyes will plant about thirty hills. The tubers will be ready for use in October, but may remain in the ground and be dug at any time during the winter.—(F. B. 255; U. Idaho 10.)

ASPARAGUS.

This valuable plant was formerly a luxury on the tables of the rich, but is now during the season a vegetable seen daily upon the

tables of people of moderate or even small incomes. It is also frequently recommended as an article of diet for the sick and convalescent. To the asparagus grower there are two methods by which plants can be secured, (1) by purchasing or saving the seed from which to raise them, and (2) by purchasing the plants from either a seedsman or some grower. Taking the second method, as being the quickest way to start a bed as well as the most easily disposed of, it is suggested that roots over two years old be rejected, and only one-year-old roots selected if a sufficient number can be secured, as the latter are much better and will in the course of a few years produce more and larger spears to the plant and yield profitable crops for a longer period. It is best to deal with reliable firms; they will be more likely to supply plants of both the kind and age desired.

Seed.—Only reliable seedsmen should be trusted, or the seed should be procured from some neighbor who has the desired variety and has taken proper care in producing and saving the seed, if the first plan is to be followed. If one already has an asparagus bed of the desired sort, producing fine spears, and of the proper age (8 to 12 years old) for seed production, it is always best to save seed from it for new plantings. The growing of one's own plants is preferable, both because of the extra year intervening between the determination to plant and the actual setting out of the bed, thereby permitting the soil of the proposed bed to be put in a better and more friable condition, and because, good seed having been secured and proper care given to the young plants, a more satisfactory supply of the young roots is obtained. That there are objections to growing one's own seed is undoubtedly true, but there are also compensating advantages, and if proper care is exercised it will pay the grower to raise his own seed (from beds which are satisfactory) even if seed can be bought in the open market for much less than the trouble of attending to the home grown may cost. If, however, a grower is unwilling or unable to exercise the necessary care in the production of seed, he would do much better not to attempt it, but depend upon some reliable dealer, studiously avoiding those whose claims to patronage are based upon cheapness of stock. Good seed are worth good money; poor seed should not be accepted under any conditions.

Soil.—Asparagus will grow on most soils, and will yield large crops upon stiff soils; but for the purpose of the grower for market, a light sandy soil of fair fertility is much to be preferred, both because of the earliness with which it produces marketable spears and the ease with which it is cultivated. A soil on which water stands after rain, or under which the standing subsurface water is near the surface, into which the roots are liable to penetrate, is to be avoided. Of course, such a soil, if otherwise suitable, can be made fit by a thorough system of underdrainage, since an occasional overflow, or even a submergence of the beds for several days, is not necessarily injurious if the drainage, either natural or artificial, is good. The soil should be free of roots, stones, or any trash that will not readily disintegrate or that will interfere with the growth of the spears. A rather stiff but naturally well-drained soil which produces early and

fine asparagus, notwithstanding the fact that it is full of large gravel, some of the stones being twice the size of a man's fist.

Shade.—Fruit or other trees or high shrubs must not be allowed in the asparagus bed, because of the shade they throw over the beds and because their roots make heavy drafts upon the soil. Nor should high trees, hedges, hills, or buildings be so near as to throw a shadow upon the beds, because all the sunshine obtainable is needed to bring the spears quickly to the surface. The land should be protected from the north or east (or from the direction of the prevalent winds) and so slope that the full benefit of the sunshine will be obtained during the whole day. Freedom from weeds is very desirable, even more so than great fertility, for the latter can be produced by the heavy manuring which the future cultivation will require; and to the end that weeds may be few, it is well that for a year or two previous to planting the land should have been occupied by some hoed crop, such as potatoes, beets, cabbages, etc.

Cultivation.—In the late fall or early winter the selected area, should be a light sandy loam as described above, needs to be deeply plowed, and if the subsoil is not already of an open and porous nature, through which surface water will readily drain and the roots easily penetrate, a sub-soil plow should follow, breaking the soil to the depth of at least 15 inches. After harrowing the field, a good compost of well-rotted horse, cow, sheep, or other manure should be spread broadcast and left to the action of the weather until as early in the spring as the ground is in condition to be worked, when the manure should be plowed in, the surface carefully harrowed, and the soil put in a light and friable condition.

As early in the spring as the condition of the ground will permit work to be done—when it is dry enough to bear plowing and the soil will break up fine—rows should be marked off 4 to 6 feet apart and opened up with a large plow, going a sufficient number of times to make a furrow from 8 to 12 inches deep. Loose soil that the plow does not throw up should be taken up with a shovel or wide-bladed hoe. It is in these furrows that the crowns are to be set, the distance to be left between plants varying, according to the opinion of the grower, from 18 inches to 5 feet.

Planting.—Rows should be run north and south, so that the full benefit of the sunshine will be secured. If the rows run east and west, they will be shaded by the ridges in early spring, when the sun is low in the south, and later in the season they will be completely shaded on one side by the tall foliage. This delays sprouting in the spring, and prevents the best development of the plants at all times. Of course, any conditions, such as the slope of the land, etc., which make it inadvisable to run the rows north and south must be considered, but southeast to northwest or northeast to southwest is better than due east or west, or, in short, the natural conditions permitting, the course should be as far from east and west as possible. This is especially important to those who ridge the rows to produce white asparagus. Early in the spring of each year, after the plants are old enough to cut, there must be a ridge made over the rows to blanch the

shoots, if white asparagus is to be cut; and once ridging is not sufficient, but after the spears begin to appear the ridges will need renewing every week or ten days during the cutting season, as the rains beat them down and the sun bakes a crust upon the top. The grower of green asparagus has about the same work, less the ridging and plowing down. As it is necessary to keep down all weeds, some hoeing may be necessary as supplementary to a free use of the 1-horse cultivator. After the cutting season, a cut-away harrow run twice diagonally across the rows loosens up the soil and destroys a vast number of weeds without injury to the crowns, although some spears may be broken off.

Brush.—The bushes should be cut as soon as the berries are fully colored, as the growth will be sufficiently matured so that no injury will be done the roots by removing the tops, thus avoiding a further drain upon the roots to mature the seed, and preventing the dropping of seed, followed by the springing up of innumerable young asparagus plants.

All brush should be promptly collected and burned, that there may be no lodging places for insects and diseases. In case the fields were not leveled, harrowed, and manured at the close of the cutting season, now is a convenient time to perform this work, although if the soil is rather too moist it is well to leave the surface firm, that the winter rains may run off rather than penetrate to the already too damp sub-soil around the roots.

Manuring.—In nothing relating to asparagus has there been a greater change than in the practice of manuring. Formerly it was thought necessary to place large quantities of manure in the bottom of the deep trenches in which the young plants were set out in order that sufficient fertility might be present for several years for the roots, as after the plants were once planted there would be no further opportunity to apply the manure in such an advantageous place; it was also considered necessary to use much manure every autumn to bank the beds in order that the crowns should not be injured by the winter's frost. These applications, especially that given prior to planting the young crowns, made the outlay so great, and that for so many years before any return would be received from the bed, that only small plantings were possible to those who were without considerable capital.

Although asparagus is still heavily manured, the amount now used is much less than was formerly supposed to be necessary, only about double the quantity ordinarily used upon root crops, such as potatoes, beets, etc. It is not a good practice to put manure in the bottom of the trenches or furrows when setting out the crowns, because it is demonstrated to be rather a waste of manure than otherwise, and besides the roots of asparagus thrive better when resting upon a more compact soil; nor is it necessary that the soil should contain great amounts of humus or be in an extremely fertile condition when the plants are first put out, since by the present system of top dressing a moderately fertile soil soon becomes exceedingly rich and equal to the demands which the plants make upon it. Considerable improvement is

produced in the mechanical condition of the soil by the use of stable manure upon beds. By the addition of humus, porous sandy soil is made somewhat more binding and its ability to take up and retain moisture thereby increased; while, on the other hand, cold, heavy soils are made warmer and more porous.

All organic manures are suitable for use on the beds; but care must be exercised in the use of any of these lest they be too hot and injure the plants, especially if applied directly to the roots and immediately over the crowns. Where the young shoots come up through it, fresh, hot manure is likely to produce rust or to render the shoots unsightly and thus injure their sale. Especially is this true in light, sandy soils.

The time of applying manure on beds, and the position where it should be placed, are of some importance. In the use of stable manure, both writers upon the subject and growers actually engaged in producing asparagus for the market almost unanimously state that "in the autumn, after the stalks have matured and have been cut, manure should be applied on top of the rows." Some give the caution not to put it just over the crowns, lest the shoots next spring be injured by contact with it. This plan of top dressing beds during the autumn or early winter is gradually giving way to the more rational mode of top dressing in the spring and summer. It was believed that autumn dressing strengthened the roots and enabled them to throw up stronger shoots during the following spring. This is a mistake.

It is during the growth of the stalks after the cutting season is over that the crowns form the buds from which the spears of next season spring, and it is probable that it is principally during this period that the roots assimilate and store up the material which produce these spears. This being true, the plant food added to the soil and becoming available after the cessation of vegetation in the autumn can have little, if any, effect upon the spears which are cut for market the following spring; it first becomes of use to the plant after the crop has been cut and the stalks are allowed to grow. In the use of hot, or fresh, manure it may be that the winter season is none too long to permit the fertilizing elements to become available and well distributed throughout the soil, but if well-rotted manure is used there is danger of the fertility being leached out of the soils by the rains and melted snows of winter.

Those growers who apply a liberal dressing of stable manure or fertilizer immediately after the cutting season supply the required nourishment to the plants at the time they most need it and can most profitably utilize it in the production of spears. Manure thus applied will also act as a mulch, preventing the growth of weeds, keeping the soil light and cool, and preserving the moisture intact. It should not be made on top of the row. This suggestion the writer wishes to emphasize.

Manuring in November in many cases does more harm than good, as the mass of manure causes many roots to decay, and those which do survive are weak and only produce small spears. It would be much better to rely upon liberal supplies of food through the grow-

ing season than to give manure when the bushes are cut, as at the former period the roots can more readily absorb the food given. By feeding in spring and summer the crowns are built up for the next season's supply of grass. The roots of the asparagus are perhaps always active, but much less so in winter than at any other season, and they will obtain as much nutriment from the soil as they can then use. If heavily covered with manure sunshine is excluded, growth is checked, and the roots have to fight hard for existence at a time when they are none too strong.

In the culture of green spears the manure is best utilized by broadcasting, this application to be followed by a thorough harrowing of the field. When white asparagus has been cut, either manuring in the trench between the ridges before disturbing them or harrowing down the ridges and then manuring broadcast is perhaps the most rational way. As between manuring in the row and between the rows, the latter should be selected as the evidently advisable one by which the feeding roots of the plants are most easily reached. Placing the manure in the row only reaches those feeding roots which are to be found about midway between the crowns, as just around the crowns are nothing but storage roots, besides it is not desirable to place manure too close to the crowns, but manuring between the rows puts the manure right where the summer rains can carry the fertility directly down into the (as it were) open mouths of the feeding roots.

Green Crop.—If green asparagus is desired, the stalks need be cut only so far beneath the surface as to furnish a 9 or 10 inch spear, the major part of which, say 6 inches or more, will be green, and of course above ground. If white asparagus is sought for, the rows will have been ridged from 10 to 15 inches above the crowns, and the spears must be cut as soon as they show at, and before they peep above, the surface. This means cutting 9 or 10 inches below the surface. To accomplish this, long chisel-like knives of various shapes are used.

Cutting should be done at least every day, and when vegetation is rapid twice each day will be necessary for white asparagus, and is often desirable when the green sort is being cut.

Harvesting and Marketing.—Asparagus is one of the earliest vegetables, especially if the roots are near to the surface or the soil above them has been temporarily removed so that the rays of the sun can easily penetrate to them. Some varieties are earlier than others, and this difference in time of appearance varies from a day or two to several weeks. For instance, the Early Argenteuil is about ten days earlier than the ordinary asparagus grown in the same locality, and the Late Argenteuil at least ten days later; so that there would be nearly three weeks between the Early and Late Argenteuil. Among the ordinary varieties, however, there is only a short period between the earliest and the latest.—(F. B. 61, 255; U. Cal. 165; U. Mo. 43; U. Kans. 70; U. Miss. 1905.)

BEANS.

Kinds.—For convenience in reference and for discussion, beans may be divided into two general groups—"field" and "garden" beans —which are by no means distinctly separate either in appearance or

in characteristics. Each of these groups can again be divided into bush and pole beans. Bush beans of the field type are recognized, for commercial purposes, under three well-marked types, known as Kidney, Marrow, and Pea beans, each of which may be subdivided into two groups, colored and white. The garden beans, like the field beans, may be divided into bush and pole types; these again into Kidneys and Limas, the term "Kidney" in this case including all of the common garden beans whether of one type or another, and this group may again be divided into wax and green pod. The same subdivision may also be recorded under pole beans, as is suggested in the following classification:

Field beans	Bush	Kidney	Colored. White.
		Marrow	Colored. White.
		Pea	Colored. White.
	Pole or corn hill.	White or colored.	
Garden beans	Bush	Kidney	Wax. Green pod.
		Lima.	
	Pole	Kidney	Wax. Green pod.
		Lima.	
		Runner (Scarlet Runner).	

Soil.—While clay loams or soils overlying limestone are most desirable, sandy and even gravelly loams may be used, but these latter soils should contain more or less humus and the gravelly soil should not be too coarse. Beans may be grown on heavy clay soils but the surface or underground drainage, or both, must be good and special attention must also be given cultural methods to produce a fine, mellow seed bed. Muck soils or those with a superabundance of humus are not suitable as they tend to produce vines at the expense of the seed. It is also true that this crop will not thrive on low, wet, poorly drained soils. Beans seem to produce good crops on soils somewhat deficient in nitrogen when well supplied with potash and phosphorus. Contrary to a somewhat prevalent notion, beans will not produce well on very poor soils, but require a fair degree of fertility.

Seed.—Care should be exercised in the selection of beans for seed. None but the best hand-picked beans should be used for planting, as the success of the crop is quite largely dependent on the vitality of the seed.

Tilth.—Since the bean is a warm-season crop and can not safely be planted until after danger from killing frost has passed, the preparation of the soil for field beans should be deferred until the vegetation covering the area has made considerable growth, so that it may be as completely destroyed as possible during the operations of plowing, harrowing, and fitting the land for the reception of the seed. The short-season character of the bean crop enables the land to be

occupied during the winter months by some cover crop, such as wheat or rye, and if the same land is used year after year for the production of beans, the turning under of winter cover crops furnishes an important means by which the store of organic matter in the soil can be maintained, a consideration of great moment in sections chiefly dependent upon commercial fertilizers as a source for available plant food.

After the land has attained proper dryness in the spring it should be plowed from 6 to 8 inches in depth, and immediately compacted and harrowed, so as to prevent the loss of moisture. The surface of the seed bed should be made smooth and fine, so that the drill or planter can be economically used upon it. If dry weather follows at this season of the year, a good practice is, immediately preceding the planting of the crop, to run a heavy land roller over the area, particularly if the planting is done with an ordinary grain drill. If the planting is done with a planter similar to the ordinary corn planter and the land has been rolled previously, it is advisable to go over it with a spike-tooth harrow or some other type of smoothing harrow after the crop has been planted, in order that the land may not possess a compacted condition from the substratum to the surface.

Planting.—Growers have found that it is better to postpone planting the crop until as late in the season as is practicable and yet be able to safely harvest the crop before the vines are injured by fall frost. The late planted crop has the advantage of escaping the most serious attacks of the bean rust. While there are undoubtedly varieties which are more or less resistant to this trouble, yet the general practice of late planting has been found to be of decided advantage. In planting the field crop the distance between the rows varies from 28 to 36 inches, according to the implements used in harvesting the crop, 30 inches being a very satisfactory and not an unusual distance for placing the rows. The seeds are so scattered as to fall from 2 to 4 inches apart in the row. The ideal distance would be undoubtedly 6 inches, if it were possible to obtain a perfect stand of plants at this distance. For distributing the seed in the row at these distances a bean planter or a check row corn planter may be set to drop the seeds in drills. A common practice is to use an ordinary grain drill and stop a sufficient number of tubes to enable two or three rows of beans to be planted at the proper distance apart without the necessity of purchasing a special implement.

Quantity of Seed.—The quantity required to plant an acre of beans varies with the size of the beans; that is, a half-bushel of small Pea beans is sufficient to plant an acre of ground, while a bushel of Red Kidney beans is hardly sufficient to plant an acre when the seed is distributed in the ordinary fashion in drills rather than in hills. In planting beans of the Pea and Marrow types the quantity of seed varies from one-half to a bushel per acre, depending upon the quality of the beans and upon the preferences of the planter. For Kidney beans the quantity varies from a bushel to as much as six pecks per acre. Ordinarily, with rows 30 inches apart, a bushel is a sufficient quantity for seeding an acre.

Depth of Planting.—The depth at which beans should be planted is determined by the character of the soil and the season of the year at which they are planted. In heavy, retentive soils planting should be made comparatively shallow, as the peculiar habit of growth of the bean is such that it can not readily reach the surface if planted deep in such soils. Upon light soils and early in the season, planting can be made quite deep. Three inches is not too deep upon such soils, but an inch and a half or 2 inches is the maximum depth for planting upon retentive soils. All things considered, a satisfactory depth for planting beans is about 1½ inches.

Cultivation.—Like all other hoe crops field beans require frequent, shallow cultivation. The stirring of the soil for the purpose of holding the weeds in check and preserving a soil mulch over the area occupied by the growing crop, is the important factor to be considered in culture. At the last cultivation the plants may be slightly hilled; that is, the soil may be thrown toward the plants with small wings. This has the advantage of leaving the plants on a slight ridge, which facilitates the work of harvesting when such work is done by mechanical means. In the cultivation of beans it is traditional that they should not be cultivated when the dew is on the vines. This undoubtedly has a slight foundation for the reason that moisture is a conveyor of spores of disease and might have a tendency to distribute them more widely than would be the case if moisture were allowed to dry off the leaves without being disturbed.

Harvesting.—For many years the handling of hoe crops, such as field beans, upon an extensive scale was impossible because of the great amount of hand labor necessary to gather the crop. Within recent years, however, labor-saving devices have been invented so that now the once laborious practice of hand-pulling individual plants can be done away with by the use of a bean harvester. After the plants are thrown together by the harvester it is customary for men with ordinary pitchforks, either 2 or 3 tined, to follow the harvester and place the beans in small heaps to cure for several days before storing them in barns or sheds for thrashing. In some instances, where the work is done upon a very extensive scale and where the loss from shelling is not considered sufficient to justify the employment of hand labor for bunching the beans with forks, an ordinary horserake is employed for the purpose. Where the beans are to remain for a longer period and to become more thoroughly cured in the field and where the work of harvesting is done entirely by hand, the crop is frequently placed in shocks which are built about a pole 4 or 5 feet in height, both ends of which have been sharpened and one end firmly placed in the ground. A small quantity of straw, grass, or other material is placed around the base of the stake, and the beans as they are pulled are piled around the pole until a compact miniature stack about 4 or 5 feet high is formed. The curing process in any case is carried far enough to prevent the vines molding after storing them in the barn prior to thrashing. If the vines are thoroughly ripened in the field before harvesting, they can be stored in from two to three days if the

weather is satisfactory. If, however, the vines have some green leaves upon them and the pods are not thoroughly dry, the period for curing in the field is of necessity much longer than with thoroughly ripened plants.

Storage.—After the crop has been properly cured in the field it is customary to store the beans in barn lofts or in sheds until the weather has become quite cool before the work of thrashing is done. In some instances, however, if the beans are thoroughly field cured they may be thrashed in the field; but ordinarily, in those regions where beans are extensively grown, weather conditions will not permit of their being cured and left in the field a sufficient period to enable the entire work of harvesting and thrashing to be carried on in the open.

Care Necessary.—All operations connected with the harvesting and field management of beans should be done as carefully as possible, in order to avoid injury to the plants while in the growing condition and to prevent shelling the beans after they have ripened. Most varieties of beans shell more or less easily after the pods have become thoroughly matured. Most extensive growers of beans consider the loss by shelling resulting from the use of labor-saving machinery of less money value than the added cost of carrying on all operations by hand in the most careful way. In other words, the loss from the use of labor-saving machinery is not sufficient to justify the return to hand labor in the care and management of the crop.

Threshing.—Beans are now threshed by a special machine or beaner which has been instrumental in materially increasing the acreage of beans grown. These machines are usually introduced into localities where beans are grown commercially and offered for hire on a plan similar to that used by grain threshers.

Cleaning and Grading.—While the farm operations in connection with the preparation of field beans for market usually cease with the thrashing of the crop, the cleaning and grading of the product is a very important item and requires much hand work. Besides the removal of sticks and straws from the grain by the use of the fan, the beans are passed through a machine which is provided with a broad, slow-moving belt placed at such an angle that split beans and peas, dirt, and stones which are not removed by the fan adhere to the belt and are thrown out, while the smooth, perfect seeds fall back into another receptacle and are thus separated from the dirt and broken seeds. After this the beans are usually subjected to a third operation, which consists in removing by hand all broken and discolored seeds, as well as foreign matter, which were not removed in the other operations.

Garden Beans.—The type as well as the variety of garden bean to be grown is determined by the purpose for which it is to be used. If it is to be used as a snap or string bean for early market, quick-maturing green or wax-podded varieties are selected. If for canning purposes, a different variety is selected, which may have either green or wax pods, while as a rule green beans which are required late

in the season for table use belong to the pole type. For early beans, however, the bush type is the one most commonly used.

Fertilizers.—While beans are quick-growing and early-maturing plants requiring an abundance of available plant food in the soil, yet, because of their family relations, being legumes, they make the soil better for having been grown upon it. They are nitrogen-gathering plants, and for this reason require only a small percentage of this element in any fertilizer used upon them. While heavy applications of fertilizers containing nitrogen, phosphoric acid, and potash are used by truck growers in the production of beans, as a rule such fertilizers should be relatively richer in phosphoric acid and potash than in nitrogen. The production of garden beans for snap or string beans, however, demands a larger percentage of immediately available nitrogen than does the production of field beans for the dry grain, as in the former case the crop occupies the land a shorter time and therefore gives it less opportunity to provide itself with a supply of nitrogen from the atmosphere. The fertilizer, if used in the form of commercial fertilizer, may be distributed broadcast over the area occupied by the crop with a grain drill or a fertilizer distributer, or it may be scattered along the row at the time the seeds are sown by one of the many types of seed drill having a fertilizer attachment.

Planting.—Garden beans, like field beans, may be planted either in hills or in drills. The customary practice, however, is to plant the seeds in drills so that they shall fall 2 or 4 inches apart in rows far enough apart to admit of cultivation with either one or two horse implements. Because of their peculiar habit of germination—the elongation of the part between the root and the seed leaves, called the hypocotyl—the seed leaves or cotyledons are lifted out of the soil. A large expenditure of energy on the part of the plant is necessary to accomplish this, and the more compacted the soil and the deeper the seed is planted the more time and energy are required in accomplishing this result. It is evident, therefore, that the shallower the beans can be planted without retarding satisfactory germination, the better. Upon thoroughly fine and compacted soils the seeds are planted from 1½ to 2 inches deep. Shallower planting does not as a rule give as satisfactory germination as planting within the range above mentioned. While garden beans are planted in extensive areas, they are, nevertheless, frequently used as a catch crop between other plants, such as squashes and cucumbers. The bean, being a quick-growing plant, matures its crop and is out of the way before the entire area is demanded by the companion crop.

Harvesting.—From the nature of the product the harvesting of garden beans for use as string or snap beans must necessarily be done by hand. Their extensive culture is therefore restricted to areas in which an abundant labor supply which can be commanded at short notice is available. After the beans are picked they are carried to a convenient sorting table, either in the open or under shelter, where they are looked over, all diseased and broken beans rejected, and the baskets uniformly filled and shaken down preparatory to covering them for shipment.

LIMA BEANS.

Under the name of Lima beans two distinct types are now recognized: Pole Limas and dwarf, or bush, Limas. Lima beans are of very great commercial value, but are not sufficiently appreciated as a table food because it is not generally known that in a dry state they can be used in practically the same manner as are the common beans. In reality they are richer and more delicate in flavor than the common beans, and can be used in as many different ways. The virtues of these types as green beans need only a passing mention, and their value as an accompaniment of corn in succotash is well known to every consumer of canned goods.

Planting.—The common method of handling the Lima bean in the climate of the northern tier of States, outside of the irrigated belt, is to plant from three to five beans in hills 18 to 36 inches apart, with the rows 3½ to 4 feet apart, and after all danger from cold and from insect enemies is past the beans are thinned to about three plants to the hill. As the beans are exceedingly tender, it is necessary to delay planting in the open until about a week or ten days after the time for planting the common garden beans. After the second cultivation, when the tendency to climb has manifested itself, the plantation is supplied with poles from 5 to 6 feet high, or with a trellis running from end to end of the row, which may be made by stretching two or three wires lengthwise of the row and weaving between them strands of ordinary wool twine. If the trellis is employed the beans can be planted in practically continuous rows, so that they stand about a foot apart. Toward the northern limit for cultivating this crop, one is fortunate if one-half to two-thirds of the pods which set upon the plants mature the seed. Farther south the crop is proportionally heavier.

In California and in other irrigated regions where there are well-marked wet and dry seasons, the dry season, accompanied by heavy fogs, occurring during the summer months, it is possible to cultivate Lima beans somewhat as follows: Upon moderately rich, somewhat sandy valley land, cultivation can be carried out by planting the beans as soon as all danger from rains has ceased and the plantation will remain dry except for irrigation. If there has not been sufficient winter rain to thoroughly moisten the land it should be well watered and allowed to dry to a good cultural condition before planting. Seed can then be planted in hills about 3½ or 4 feet apart each way, or in drills, the beans scattered about a foot apart in rows 4 feet apart. After the beans have germinated it may be necessary to cultivate them once or twice with a sweep of some type, to destroy any weeds which may have sprung up from the moist ground. All moisture should be withheld and a dust mulch over the surface preserved by running a sweep over the plantation once or twice more, and then the vines should be allowed to take possession of the territory. This obviates the necessity of using poles, and the crop can grow to maturity under these conditions without irrigation, without cultivation, and without poles.

At harvest time a root cutter is passed under the lines of the

rows, severing the roots of the plants, and after the plants have dried and become somewhat cured they are thrown into convenient heaps for loading on wagons and are allowed to remain in these heaps until near the approach of the rainy season. Then they are carried to the thrashing floors, where they are beaten out by the tramping of animals or by driving over the heap a device somewhat similar to the ordinary cutaway harrow.

The dwarf Lima beans, because of their habit of growth, are planted and cultivated practically the same as are field beans. They are slightly hardier than pole Limas, and for that reason toward the northern limit of the range of this crop can be planted somewhat earlier in the season than the pole Limas.—(F. B. 289; U. Mich. 259; S. C. E. S .10; S. Dak. E. S. 47, 91; Iowa E. S. 47; Miss. E. S. 131.)

BEETS.

The red garden beet may be grown in any good soil, but rich, sandy loam will give the best results. Sow the seeds in the spring as soon as danger of frost has passed. Beets should be planted in drills 12 to 18 inches apart, and when the plants are well up they should be thinned to 4 or 5 inches in the row. If desirable to plant in rows 3 feet apart for horse cultivation, the seeds may be sown in a double drill with 6 inches between, leaving 30 inches for cultivation. Two ounces of beet seed are required to plant 100 feet of row, or 5 pounds to the acre. As a rule each seed ball contains more than one seed, and this accounts for beets coming up very thickly. The seed should be covered to a depth of about 1 inch. For a succession of young beets during the summer, plantings should be made every four or five weeks during the spring months. Beets intended for winter storage should not be sown until late in the summer, the crop being harvested and stored in the same manner as turnips. Sugar beets are often substituted for the ordinary garden beet, especially for winter use.

A soil that is well adapted to growing the usual vegetables will be found good for this one. It may be slightly heavier than that for the crops that are grown for their foliage, as lettuce. A good cabbage soil will be found of about the right consistency. Wet or soggy land will not raise a crop. Plow deep and prepare the ground well; the seedlings are quite small and need considerable coaxing before they will make a good start. Use plenty of fertilizer of some well prepared kind. Rough or undecomposed material should not be used. A sprinkling of powdered nitrate soda as a top dressing when the plants are one-third grown will produce a rapid growth. In applying, be careful not to apply so as to touch the foliage, unless during a rain. It is not profitable to transplant beets; it may be done on a small scale, but it is too expensive to practice on a large scale.

Varieties.—According to shape of the root one may divide beets into two classes, viz., Long Rooted and Globular. If color is made the basis of classification you have red, white and yellow kinds. Extra Early Blood Turnip, Eclipse and Extra Early Egyptian are good varieties to grow for market. The first named is probably the best; the last named has the disadvantage of becoming stringy if it ma-

tures during a long, dry spell, or if allowed to stand too long. The deep red varieties are preferred in the markets, and those that are turnip shaped sell better than the long.

Marketing.—The usual method is to use barrels or large boxes; this is a clumsy way, and one not calculated to bring the best price. The usual vegetable crate will be found handy and desirable.

In districts where there are pickling factories, and near large cities, small beets, with greens, are raised with profit, but these can not be shipped to a distant market. For a distant market gather tops and all; carry to the packing-house; remove the tops with a sharp knife, leaving about an inch of the leaf-stalk on the beet. Remove the dirt, and pack in vegetable crates. The leaves put in a compost heap will pay for the trouble of hauling, or they can be fed to domestic animals with profit. The beet itself makes one of the best feeds for milch cows, and is excellent for other domestic animals.—(F. B. 225; N. C. A. E. S. 132; Fla. E. S. 31; U. Idaho 10; N. H. Col. 99, 125; N. J. A. Col. Rpt. 1900.)

BORAGE.

The leaves are used for flavoring.

BROCCOLI.

Broccoli is simply a variety of cauliflower that is more commonly grown for fall use, as it is rather more hardy than the true cauliflower. Lee's Sprouting Broccoli is a branching sort that is esteemed in some places. There is a great deal of misunderstanding regarding the Cauliflower and Broccoli. Both are the same in their general make up and growth, both producing heads in the same manner and to the casual observer are taken one for the other. The difference is that Cauliflower is a more tender variety and therefore will not stand a very low temperature. The seed is sown in early spring and will produce heads during the summer. The Broccoli will stand a temperature as low as 25 without much injury to the plant. The seed is sown in the spring, the plants set out in June or early part of July and continue to grow until the spring following, some varieties producing heads at intervals during winter and up to as late as May. Attention needs to be directed during the winter to such plants as are about to produce heads. These should have the outer leaves turned over the head to protect it from frost to which it is very susceptible. The seed may be sown and the plants treated in every way as for the cabbage. They thrive well in a deep, rich soil. Much better results would be had if more attention were given to the matter of deep cultivation, that is, in deep spading or plowing of the ground. Manure that has been well composted should be used plentifully and plowed in deep. By so doing the roots of the plants are encouraged to penetrate deep into the soil where they can find moisture as well as food. The shallow plowing in of manure has the tendency to keep the feeding roots of plants near the surface and will therefore soon dry out and turn blue, and when once the plants are stricken with the blues no further growth will be made and they might as well be discarded.—(Oreg. E. S. 74; N. C. E. S. 132.)

BRUSSELS SPROUTS.

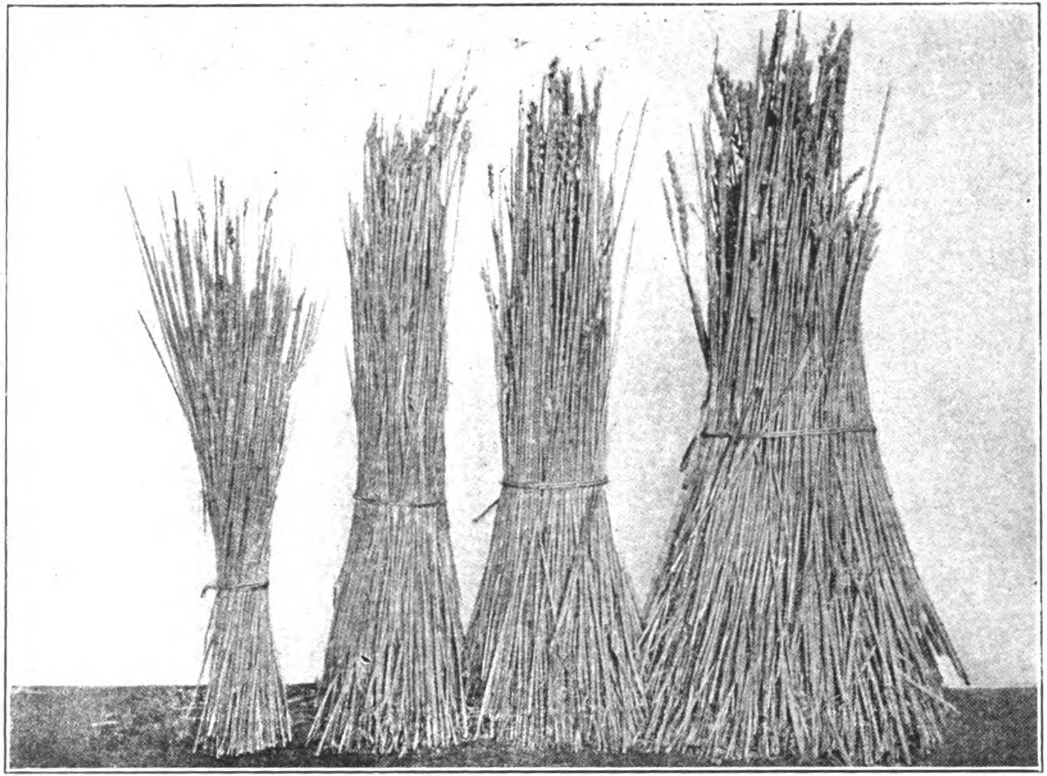
This crop is closely related to cabbage and cauliflower. Instead of a single head, Brussels sprouts form a large number of small heads in the axils of the leaves. As the heads begin to crowd, the leaves should be broken from the stem of the plant to give them more room. A few leaves should be left at the top of the stem where the new heads are being formed. Brussels sprouts are more hardy than cabbage, and in mild climates may remain in the open ground all winter, the heads being removed as desired. For winter use in cold localities, take up plants that are well laden with heads and set them close together in a pit, cold frame, or cellar, with a little soil around the roots. The uses of Brussels sprouts are similar to those of cabbage, but they are considered to be of a superior flavor. They require the same treatment as cabbage. The soil must be rich and requires considerable moisture. The small sprouts must grow rapidly or they will be tough. Sow the seed in hot-bed and transplant, or scatter seed in hills and thin. The plants must have plenty of room. Rows should be thirty inches apart and the plants not closer than two feet. —(F. B. 255; U. Idaho E. S. 10; Cornell U. E. S. 292.)

CABBAGE.

Cabbage is one of the most universally cultivated of the garden plants. Although it is one of the coarser vegetables it finds a place in the home garden as well as in the market garden and truck farm. In some sections of the United States it is extensively grown as a farm crop. Early cabbage is practically all consumed as a green vegetable. The late crop, on the other hand, is handled as a fresh vegetable, as a storage crop, and for the manufacture of sauerkraut. It is always in demand, and under present conditions is always available, either as the product of a southern truck farm or a northern farm, garden, or storage house. The group of cultivated plants which has been derived from the wild cabbage presents a greater diversity of form than that derived from any other single ancestral type.

Wild cabbage is a robust-growing broad-leaved plant enjoying the low, moist areas near the seacoast of southern Europe. The most closely allied form now in cultivation is the collard. The wide variation in the group is illustrated by the diversity of form shown in collards, kale, tree cabbage, marrow kale, cauliflower, and Brussels sprouts. It is almost beyond the bounds of reason to believe that all these forms have been derived from a common parentage, yet such is the fact.

Seed.—In no truck crop does the character of the seed count for more than in cabbage. It is very essential that the crop come to marketable maturity early, that the heads be uniform in size and character, and that they mature so that the whole crop can be harvested at two cuttings. The small saving made by the purchase of cheap or inferior seed is usually paid for a hundred times over in the lessened value of the crop. A grower can not afford to risk his crop for so small a saving. The best seed that can be obtained is none too good, and anything short of this is not good business. Without



Chili Wheat—Each Bundle Shows Straws Produced by 50 Seeds. Planted 2, 4, 6 and 12 Inches Apart. Dept. of Agr.

(See pages 376-379; 442 463.)

highly viable seed of a good strain, true to type, the best results can not be expected. For early spring cabbage in the South, sow the seeds in an outdoor bed and transplant to the garden before January 1. In the North, plant the seeds in a hotbed during February and set the plants in the open ground as early as the soil can be worked. For a late crop in the North, plant the seeds in a bed in the open ground in May or June and transplant to the garden in July. Early cabbages require a rich, warm soil in order that they may mature early. For late cabbages the soil should be heavier and more retentive of moisture and not so rich as for the early crop, as the heads are liable to burst. Cabbages should be set in rows 30 to 36 inches apart and 14 to 18 inches apart in the row. Where the plants are set out in the autumn and allowed to remain in the ground over winter, they are usually placed on top of ridges.

Soil.—The soil for cabbage must necessarily vary in different localities. In one area it may be of an alluvial character, while in another it may be sedentary, and in still another it may be characteristic glacial drift. The fact that cabbage grows well in all these soils indicates its adaptation to a wide range of conditions. The main thing with cabbage is an abundant supply of immediately available plant food. Market gardeners rely chiefly upon stable manure for their supply of plant food.

Cultivation.—Among market gardeners it is a common expression that "cabbage should be hoed every day." Perhaps no other crop responds more quickly to good cultivation and an ample food supply. This is undoubtedly the explanation of the above quoted expression. In cultivating cabbage the work should be frequent and thorough, but the cultivation should not be deep. The aim should be to destroy all competing weeds and to maintain a loose, friable layer of soil about 2 inches deep over the surface of the area devoted to cabbage.

Storage.—Early cabbage must be used soon after it has formed solid heads, as it will not keep during hot weather. Late cabbage may be buried in pits or stored in cellars or specially constructed houses. The usual method of storing cabbage is to dig a trench about 18 inches deep and 3 feet wide and set the cabbage upright, with the heads close together and the roots bedded in soil. As cold weather comes on, the heads are covered slightly with straw and then 3 or 4 inches of earth put on. Slight freezing does not injure cabbage, but it should not be subjected to repeated freezing and thawing. If stored in a cellar or building, the heads are generally cut from the stems and stored on slatted shelves or in shallow bins. While in storage, cabbage should be well ventilated and kept as cool as possible without freezing.

Varieties.—The varieties of cabbage used in the trucking section are practically limited to the Wakefield type. There are two strains of this type of cabbage now extensively employed: The true Jersey Wakefield, with its small, acutely pointed tip and very firm, tender flesh of high quality, and the Charleston Wakefield, which is broader, somewhat flatter, more obtusely pointed, and slightly more

angular in cross section than the Jersey type. The varieties which may be used for field cultivation depend upon the purpose for which the cabbage is intended. If for sauerkraut or for immediate consumption, the Flat Dutch type from American-grown seed is extensively employed in the eastern part of the United States. In the irrigated section of Colorado, in the vicinity of Greeley, where cabbage is grown for sauerkraut, a variety known as Scotch Cross is almost universally grown. If the cabbage is intended for storage the Danish Ball Head from imported seed is almost exclusively used. —(F. B. 255, 433; Colo. E. S. 143; Md. Ag. Col. E. S. 133; Tex. E. S. 52, 69; Ga. E. S. 91; Kans. E. S. 70; S. Dak. E. S. 91.)

CALABASH.*

The increasing popularity of calabash pipes made from the fruits of a South African calabash, or gourd, has aroused a widespread interest in the growing of this vine.

Calabash pipes made from imported South African gourds have been the fashion in England for some time and are now coming into vogue in America. These pipes are formed from the crooked necks of a large gourd (*Lagenaria vulgaris*) belonging to the well-known group of plants which includes the cucumber, the melons, and the squashes. Pipes made from the imported gourds are expensive, American dealers usually charging $3 to $12 apiece for them. They are the lightest pipes made for their size, are graceful in shape, color like meerschaums, and are delightful smokers. Unlike the cheap pipes which are turned out by machinery, no two of these calabash pipes are alike. In this lies much of their charm. In this, likewise, lies their cost, for, unlike the great mass of pipes turned out by machinery, the crook of the calabash varies so that each mouthpiece must be made to fit it and each lining of meerschaum or plaster of Paris must be specially adapted. In our land of labor-saving machinery and expensive hand labor this is what makes the pipes costly.

The vine forms a very satisfactory cover for unsightly brush heaps or fences, though its rather rank odor might prove objectionable if used for an arbor too near the dwelling. To grow the vine for the sake of its gourds is where the chief interest lies, however, and to do this well it should not be trained on a trellis, but allowed to trail over the ground. If the fruits are allowed to lie on the ground they form their crooked necks quite naturally without assistance, and while not all of them by any means make suitable necks for pipes a good proportion do. It seems to induce a more perfect neck to stand the gourds up when half grown so that they rest on their big ends. Unless care is exercised in doing this the necks snap off, for they are extremely brittle even when fully grown. It is only when almost mature that they become hard and then they are indeed almost unbreakable.

Much could doubtless be done to perfect the methods of culture, insuring perhaps a greater percentage of properly crooked necks and more perfect surfaces. It could not be seen that inheritance plays any material part in this matter of percentage of crooks. If left to

* See page 321, for illustration.

themselves the majority will crook their necks, but some few will remain quite straight, and this on the same vine with perfectly formed crooks. The gourds should be left as long as possible on the vines to thoroughly thicken their shells. If picked green the shell will be no thicker than stiff cardboard and in drying it is very liable to crack. Frost will injure the gourds if they are left on the vines too long.—(B. P. I. Cir. 41.)

CANTALOUPE.

Cantaloupe growing, as developed since its origin near Rockyford, Colorado, in 1885, requires unusual judgment and cultural skill on the part of the farmer. Co-operative organization and good business management are also essential, for only by these means can the crop be properly timed and prepared for shipment, and necessary arrangements made with transportation and selling agencies.

Seed.—Seed should be most carefully selected with reference to flavor and appearance of the fruit; to good shipping characters, including small cavities and heavy netting; and to a tendency to produce melons of standard size. Early strains are desired for some situations; but in Arizona rust resistance is not a necessary character as this class of diseases is little to be feared under the arid conditions. Seed should be purchased only from most reliable sources. Rockyford growers are at present the principal means of supply.

Soil.—Experience has proven that a sandy loam is the soil best suited for cantaloupes, and that its condition of tilth and the available fertility are the prime essentials in bringing cantaloupes to quick maturity. The secret of getting soil in that ashy, mellow condition so desirable for cantaloupes is largely one of experience, for hardly two farms can be handled the same. In general, there must be moisture in the soil over winter to get the disintegrating effect of frost, and plowing should not be done until the ground is dry enough to pulverize mellow. Barnyard manure has long been the means of supplying fertility to force cantaloupes to early maturity. Old alfalfa ground is most excellent for cantaloupe culture. Bermuda sod plowed up and exposed to the sun without irrigation the preceding summer makes excellent cantaloupe ground, the intensive cultivation necessary serving both to benefit the crop and to restrain this formidable weed.

Planting.—The first requisite aside from moisture for a good start is warm weather, as cantaloupe seed cannot germinate when the ground is cold and freezing; and if perchance the days are warm enough to germinate the seed that is planted in March or April, the cold nights that are sure to follow will offset the advantage of early planting. If there is a secret in getting early cantaloupes it is in growing the crop from start to finish with a uniform unchecked growth; the cantaloupe does not seem to have the power to rally from a check in growth or an injury from an insect and still makes its normal development. The back-set not only cuts off the production of early cantaloupes but seriously affects the size and quality of the melon. There are numerous instances where unfavorable conditions of growth have produced a large quantity of pony melons, while

under more favorably growing conditions the same seed and soil have yielded standard sized cantaloupes. One of the first signs of promise for early cantaloupes is a quick germination and rapid development of large cotyledons. Seed that germinates slowly with small, yellow appearing seed leaves has never made early cantaloupes.

Irrigation.—Moisture for the cantaloupe hill is generally supplied by the irrigation furrow. It should always reach the seed or plant by soaking through the soil. Irrigation should never be allowed to over-soak or flood the ground, as the soil will then become hard and not permit a good growth. The relation of irrigation to an early set of cantaloupes is a somewhat mooted question. There are growers who argue the use of frequent irrigations during the setting period to secure a good set, and there are others who prefer to keep the vines rather dry and even letting them show the need of water before they will irrigate during the setting stage. There have been results that seemed to support both theories, yet close observation would not warrant following either plan to an extreme, but rather a medium course of supplying enough moisture for an even, healthy growth, which seems to be the essential condition all the way through. An excess of irrigation during the hot weather in July will doubtless tend to grow vines at the expense of early fruit; but the most disastrous result of too much water—having the ground so soaked that the surface is nearly all wet, and affording the moist, dewy condition which is favorable to its development—is in the development of rust. The rust problem is a serious one in cantaloupe culture in Colorado. Controlling it by proper application of irrigation is only a palliative measure, yet a marked contrast is often seen in two portions of a field; one over-irrigated, and the other comparatively dry, aside from the moisture necessary to the growth of the vines. Rainy weather and dewy nights afford the proper conditions for the growth of the rust spore, and while the farmer cannot change climatic conditions, yet by careful attention in the application of water, having the rows well ditched, and with adequate waste laterals to prevent over-soaking and flooding, the surface of the ground will dry rapidly after a rain or an irrigation. Thus the dews at night will be less, and in a measure alleviate the effects of rust.—(U. Ariz. Cir. 77; Ag. Col. Colo. 62, 85, 95 and 108.)

CARDOON.

The cardoon is a thistle-like plant, very similar in appearance to the Globe artichoke, but is grown as an annual. The seeds are sown in early spring in a hotbed or cold frame and the plants transplanted later to the open ground. The cardoon should be planted in rows 3 feet apart and 18 inches apart in the row on rich soil, where it can secure plenty of moisture and make rapid growth. Toward autumn the leaves are drawn together and the center blanched in the same manner as endive. If intended for winter use, the leaves are not blanched in the garden, but the plants are lifted with considerable earth adhering to the roots and stored closely in a dark pit or cellar to blanch. The blanched leaf stems are used for making salads, soups, and stews.—(F. B. 255.)

CARROT.

The culture of the carrot is practically the same as the parsnip, except that carrots are not thinned so much and are allowed to grow almost as thickly as planted. Carrots should be dug in the autumn and stored the same as parsnips or turnips. Any surplus can be fed sparingly to horses, mules or cattle. The roots of the carrot are used at all times of the year, mostly in soups, but they may be boiled and served with butter or creamed. Carrots are planted in rows 16 inches apart and the plants thinned out to 4 inches in the row. Chantenay is an excellent table carrot of medium size and dark orange color, slightly tapering and abruptly terminating with a short, fine taproot. The flesh is orange colored, brittle, juicy and mild flavored. What it lacks in size it makes up in quality and good shape. Scarlet Intermediate, somewhat larger than Chantenay, is of good size for table use. In shape more tapering and with a longer taproot. It is dark orange colored; flavor and quality good. Flesh is quite brittle and orange colored with a white center. To these two are added two varieties principally grown for stock feed, similar varieties being grown for table use in many parts of Europe, and more especially those of the White Belgian variety. Both varieties are of slender shape, 1½ to 2 inches in diameter, holding their size well, although averaging 12 inches in length, 3 to 4 inches of which grows above ground and which as a consequence is colored light green on the outside. White Belgian is the sweeter of the two, and while the flesh is somewhat coarse, the flavor of it, when well stewed and mashed, is sweeter and not unlike that of the parsnip. Victoria, the other variety, is of the same texture, fairly sweet and with a more pronounced carrot flavor, the flesh instead of white, being light orange colored. This vegetable can be grown to perfection in Porto Rico almost any time of the year. It prefers a rich loam and grows very well on a heavy clay which is not to wet, but a light sandy soil is not well adapted to it. For fertilizer, stable manure will do when nothing else is available, but a commercial fertilizer, rich in potash and phosphoric acid, is much to be preferred for this crop.—F. B. 255, 295; Mich. E. S. 20; N. C. E. S. 132; U. Idaho E. S. 10; P. R. A. E. S. 7.)

CAULIFLOWER.

This plant requires a very rich, moist soil. Land that will produce only a fair crop of cabbage is unfit for cauliflower. If the land is very rich and well fertilized it may be reasonably expected that the returns from the crop of cauliflower will more than repay the cost of putting the land in good condition.

Seed.—No more important element enters into the success of the cauliflower crop than the quality of the seed and to the seed alone is often due the difference between success and failure, profit and loss. The best seed that can be secured is the cheapest at any reasonable price, and it should always be obtained from a well-known, reputable seedsman.

Seed-bed.—This should be carefully prepared. The soil should be enriched with a liberal application of commercial fertilizer, or thoroughly decomposed stable manure. After the fertilizer is applied

it should be thoroughly worked in to a depth of three or four inches. From a few days to two weeks should elapse before the seed is sown for there is great danger in planting seed too soon after applying commercial fertilizer as the seed is likely to be destroyed by the action of the mineral substance unless it has been dissolved and thoroughly incorporated with the soil. The time between the application of the fertilizer and the sowing of the seed will depend upon the amount of rainfall and it is often better to wet down the seed-bed each day for four or five days before planting and not to depend upon the uncertain rainfall. The rows should be about three inches apart. In six or seven days the young plants should begin to appear and the ground between the drills should be cultivated. Do not allow the soil to dry out as the cauliflower plant from seed to head should never be checked. Neither should the bed be kept too wet, else there is danger of "damping off." The bed should be carefully watched and if the disease does break out it may be checked by removing the diseased plants, working the soil, scattering dry sand and sulphur along the rows and withholding water until the surface soil becomes dry. It might be pointed out here that about six months must be allowed from the sowing of the seed until the crop matures.

Transplanting.—The plants should not be allowed to remain long in the seed rows. If left too long they will soon crowd and become weak and spindling. When they have reached the height of one inch, they should be pricked off and set in another portion of the bed. They may be set in rows four inches apart with the plants one and a half to two inches apart in the rows. Here they should remain until ready for the field. If care has been exercised all the way through, the plants will be short, stocky and vigorous. By the time they are four or five inches high or when the leaves have lapped they are ready for the field. It is not best to let them get too large, because there is often a delay of a few days in order to obtain good climatic conditions for setting out. If left too long in the seed bed, greater care must be exercised in transplanting, else the plants may suffer a severe check and will button or break irregularly instead of forming smooth well shaped heads.

Soils and Preparation.—Work should be started on the ground at least a month before the plants are set out. The cauliflower is a deep rooted plant, consequently the soil should be prepared deeply. It is not advisable to turn under the good surface soil and to obviate this ground may be plowed shallow and then stirred and opened with a bull-tongue to a depth of seven or eight inches. After this the surface should be cultivated to a depth of two or three inches. Give thorough preparation by frequent cultivation before the fertilizer is applied, preparatory to setting out the plants.

Setting Out.—It is best that the plants be set out either just before or immediately after a rain, but if this can not be done they should be set out late in the evening and watered, giving each plant about a quart of water. A cloudy day is much preferable to a clear one and if the day on which the plants are set out is followed by cloudy weather, so much the better. The ground should be leveled

or smoothed over, for which purpose a roller or float may be used. After this the ground may be marked off. Two markers should be constructed, one with the teeth three feet apart, the other with the teeth two feet apart. These may be made of wood after the pattern of an ordinary garden rake. In place of a marker a line may be used or the ground may be checked off with a light hand plow. Only a limited number of plants should be removed from the seed-bed at one time. The leaves should be cut back about one-half or one-third, using for the purpose a large pair of shears. Sprinkle the plants with water as soon as removed from the bed, place in a shallow box or basket and keep them shaded from the sun.

Cultivation and Care.—The field should be frequently cultivated and the ground should be scarified at least every week and after every rainfall. The best tool for cultivating is an ordinary cultivator and the ground should not be worked to a greater depth than two and one-half or three inches. This will preserve a surface mulch of dry earth and prevent loss of moisture by evaporation. As soon as the heads commence to form the leaves should be drawn together at the top and loosely tied near their tips with a piece of cord or twine. Rafia makes a good substitute for twine and is preferable because there is less danger of cutting the leaves. The practice of breaking down the leaves over the head has been tried, but found not quite so satisfactory. If the heads are left uncovered they become yellow through the action of the sun and rain but when the leaves are drawn together and tied, they bleach out pure white, and curd-like.

Gathering.—Cauliflower may be cut before it is mature, but the flavor is not so well developed as it is when the heads are full grown. For winter shipment heads from four to six inches in diameter are of a desirable size and the market will take them fully as well or better than large ones. The field should be picked over at least every two or three days during the season, though heads will remain in good condition for nearly a week if the weather be cold. Examine the head by separating the leaves on the side. As soon as the head is well rounded up in the center and developed so as to force the leaves outward, and assumes a grained appearance, it will be found to be fully matured. The heads should be cut, preferably, when dry. If moist they are likely to decay in transit. The best time of day is the afternoon if they are intended for long distance shipment. About an inch of stem should be left on the head and three rows of leaves. After cutting, the heads should be carefully placed in a wagon and carried to the packing house or on dry pleasant days packing may be done in the field.

Packing.—The package recommended for general use is the ordinary lettuce basket. Before packing, the leaves should be cut back to stubs. Each head should be carefully wrapped in a large sheet of white glazed paper. The baskets should be packed snug and tight without bruising the heads, and only those of uniform size should be placed in each basket. Never place different sizes in the same package and always discard inferior or injured heads; the compost heap is the place for them.—(F. B. 255; Fla. E. S. 59; Tex. E. S. 57; Cornell U. E. S. 292.)

CELERIAC.

This vegetable, which is also known as turnip-rooted celery, or knot celery, is closely related to our ordinary celery, being indeed a cultural variety of the same original plant grown under conditions which have developed the root rather than the stalk. In Europe it is by far the most common form of celery, but has never been extensively cultivated in the United States, though it is found in the larger markets. The roots are white and more or less globular in shape, closely resembling turnips in appearance. This vegetable deserves to be more widely known, being extremely hardy and of easy cultivation. It is mostly used for flavoring soups, except by the Germans who use it in the same manner as potatoes for potato salad. Planted 7 or 8 inches apart and 3 feet between the rows it will yield abundantly, and succeed best where celery will. The edible portion develops into a bulbous root weighing 4 to 6 ounces when trimmed, and these bulbs when properly packed away in the cellar will keep almost until spring. Where the ground but slightly freezes, the plants may be safely left unharvested for spring use.—(F. B. 255, 295; Mich. E. S. 20.)

CELERY.

The ideal climatic conditions for the production of celery are bright sunshine, pure air, cool nights, and a well-distributed rainfall of about 8 inches during the growing period in the field or garden.

Soils.—In the production of celery for domestic use, a rich, mellow, sandy loam will give the best results. The soil of the seed bed should contain plenty of leaf mold and should be passed through a sieve having not less than six meshes to the inch. The soil of the transplanting bed need not be sifted so fine, and some well-rotted barnyard manure should replace a part of the leaf mold; in other respects it should be the same as that of the seed bed. Any fertile, well-drained soil will grow celery, but a loose, sandy loam is preferable. If nothing but clay soil is available, it may be made to produce good celery by the liberal application of well-rotted barnyard manure. On clay soils there is likely to be injury caused by the soil becoming washed into the hearts of the plants while they are yet small.

Fertilizers.—For the production of the home supply of celery there is no fertilizer that is so satisfactory as well-rotted barnyard manure. In many localities the supply of manure is limited, and it may be necessary to depend almost entirely upon commercial fertilizers. If fresh stable manure is used, it should be plowed under in the autumn. If the manure is well rotted, it may be plowed under early in the spring or used as a top-dressing a short time before planting in order to bring the manure to the surface. From 10 to 20 tons of manure to the acre should be applied each year that the land is planted to celery. The application of lime will improve most soils. Following the use of stable manure an application of 1,000 pounds of ground quicklime as a top dressing will be beneficial. Soils that are liable to leach during the winter can be held by planting to rye and the crop turned under quite early in the spring. When applied to clay soils the lime has a tendency to lighten them, and sandy soils are

rendered more retentive of moisture by the addition of lime. An application of 500 to 800 pounds of common salt to the acre is considered desirable by some growers. Celery will take up a limited quantity of salt, and its flavor is improved thereby.

One to 2 tons of high-grade fertilizer to the acre may be profitably applied on most soils in addition to the stable manure and lime. As a rule, the quick-acting fertilizers are used, and a mixture suitable for growing celery should contain about 6 per cent of nitrogen, 5 per cent of available phosphoric acid, and 10 per cent of potash.

Time and Method of Plowing.—As a rule the land should be plowed several weeks before planting. At the North it is desirable to plow the celery land in the autumn and allow the soil to lie exposed to the action of frost during the winter. At the South it will be necessary to plow but a short time before planting. The plowing should be very thorough, and in most cases with a somewhat heavier plow than that generally used for other crops.

Smoothing and Pulverizing.—A few days before the land is required for planting, the surface should be cut with a disk or cutting harrow, followed by such tools as are necessary to pulverize the soil to a depth of 5 or 6 inches. Just before planting, the land should either be rolled or gone over with a float, or drag, made by nailing together planks or scantlings, in order to secure an even surface for planting.

Marking Rows.—The rows in which the celery plants are to be set should not be marked until a short time before planting, in order that the soil may remain fresh. A marking device similar to the ordinary corn marker may be used, but some form of roller with a number of projecting pegs to form holes in which to set the plants is desirable. A device of this character can be constructed by replacing the wheel of an ordinary wheelbarrow with a roller having a series of pegs.

Selection of Seed.—The first and most important consideration when preparing to grow a crop of celery is the securing of good seed, not merely seed of which a large percentage will germinate, but that having strength and vigor sufficient to give the seedling a good start. As the seeds of celery are very small, it is necessary that only a small percentage of the number usually sown should actually grow in order to secure an abundance of plants; but as low germination and the necessary vigor are seldom both to be found in the same packet of seed that seed which has a high percentage of germination is preferable.

Sowing for an Early Crop.—For sowing seed during the early part of the season, the plan best suited to the requirements of the farmer or amateur grower of celery is to secure a wooden flat or tray about 16 by 24 inches in size and 3 inches deep, with several small holes in the bottom for drainage. After filling with sifted soil level it off even with the top, and either shake down the soil or press it down by means of a board before the seeds are sown. Either sow in drills 2 inches apart or scatter broadcast, and cover the seed by sprinkling through a fine sieve a very small quantity of leaf mold or

sand. This tray can be placed in the window of a moderately warm room in the dwelling, and the soil should be watered by sprinkling very lightly as often as necessary to keep the surface from showing dryness, but the soil should not become waterlogged.

Sowing for a Late Crop.—The method now in use by most large growers is to prepare a tract of land by pulverizing with horse tools and then raking by hand, after which the seed is sown broadcast by means of a wheelbarrow grass-seed drill. The soil is sometimes pressed down with a plank after the seeds are scattered, but some growers maintain that there is a decided advantage in leaving the soil slightly uneven, as the seeds fall into the shaded places and are protected from the direct rays of the sun. The seed will become sufficiently covered by rains or by watering. Should more than 20 per cent of the seed usually sown germinate, it is necessary to thin out to prevent overcrowding, with its attendant injury. To prevent the surface of the soil becoming too dry, it may be necessary to partially shade the young plants during the warm days of early summer, but the shading should never be so dense as to cause them to become "drawn."

Transplanting.—In case the grower adopts the plan of transplanting twice, the seedlings will be ready for the first handling in from four to six weeks from the time the seed is sown. The seedlings may be transplanted to trays or to beds in the open ground. This transplanting answers two purposes: (1) The seedling plant of celery has a straight root, or taproot, which is broken in transplanting, causing a large mass of fibrous roots to be formed. In the case of a plant allowed to remain in the seed bed until planting-out time this taproot has gone far down into the soil and the plant has formed very few side roots; consequently it suffers a great shock in the process of planting in the field, and a large number of plants will need to be replaced. (2) When transplanting twice is practiced there is no necessity for thinning, and a more uniform lot of plants is obtained. Two handlings can not be recommended when celery is grown on a large scale, as the cost of labor is too great. It is better to have a surplus of plants and to renew those that fail.

Watering.—When the seed bed is prepared, the soil of which it is composed should contain as much moisture as possible and yet be in good condition to handle. After sowing and covering the seeds the bed should be sprinkled lightly. During the period between seeding and the appearance of the plants the bed should be watered only as often as it shows indications of dryness; however, the surface should never become dry. During the first few days a moist cloth may be spread over the surface of the seed bed in order to conserve the moisture, but this covering should be removed before the seedlings begin to appear. After the plants are up, care should be taken not to water too heavily, as the seedlings are liable to "damp off"; but the ground should never become so dry as to check their growth. Celery requires the most water while making its greatest growth, which occurs late in the summer. As the crop approaches maturity the water should be applied sparingly, and it should be withheld altogether for

some time before blanching. Among the methods of applying the water, the most simple and usually the most desirable practice, especially where the surface of the soil is even, is to run the water along the rows by means of small furrows, 8 or 10 inches distant on either side of the row. This method is well adapted to use on a gentle slope with the rows running up and down the incline. When the water is sprinkled over the entire surface it should be done late in the day, so that the soil may, during the night, absorb the moisture and prevent a crust being formed, as would be the case were the water applied under the direct heat of the sun.

Growing Without Irrigation.—For a home supply of celery it is often possible to select a rather moist but well-drained piece of land whereon it may be grown without artificial watering. In this case the plants should be set while the atmosphere is filled with moisture, preferably between gentle showers, and the moisture afterwards retained in the soil by frequent shallow cultivation or by the application of a mulch around the plants. This method can not be followed in climates where irrigation is necessary for the production of crops, but is applicable in regions that have an ordinary rainfall during the growing season.

Planting.—For domestic use, where plenty of land is available, it will be found most economical to plant in single or double rows 4, 5 or 6 feet apart, with the plants 5 or 6 inches apart in the row. If the space is limited, solid beds about 5 feet wide will be found suitable, with the plants set 7 or 8 inches apart each way. By planting in rows the crop may be worked with a horse cultivator or a wheel hoe and the banking more easily done, and thus the cost of production is lessened. With the solid-bed system the work must all be done by hand. If possible, the planting should be done when the soil is rather moist and the atmospheric conditions suitable to the subsistence of the plants until the roots can again furnish sufficient moisture to supply them. The bed should be thoroughly watered a few hours before the plants are removed, and a knife or trowel should be run between the plants so that they may be lifted with a clump of earth and with most of their roots attached.

Mulching.—In muck soils it will not be found necessary to mulch the ground around the plants after setting, but some kind of a covering is desirable on sandy and clay soils. As soon as the plants are in position and before any water is applied, cover the ground for a distance of 8 or 10 inches on either side with any finely divided material that will shade the top of the soil and prevent a crust being formed after watering; half-rotted manure is preferable for this, as it aids the growth by its fertilizing qualities. Good celery can be grown on clay upland with but one watering—at the time of planting—provided that plenty of mulch is applied as soon as the plants are set. The roots of celery, after it is once transplanted, run close to the surface, and the mulch will protect them from the heat of the sun. Among materials that may be used for a mulch may be mentioned pine needles, leaves of any kind, straw, cornstalks run through the cutter, clippings from the lawn, etc., none of which, however, are as

good as barnyard manure. Have the material to be used as a mulch near at hand, and as the plants are set cover the soil around them to a depth of 2 inches, bringing the mulching material up close to the plant, but being careful to allow none to get into the heart. Apply the mulch before watering, if possible.

Where celery is planted in single rows and mulched it will only be necessary to maintain shallow cultivation between the rows, not allowing the cultivator teeth to come nearer the plants than the edge of the mulch. Where no mulch is used the cultivation may be carried a little closer to the plants, but should be very shallow, and at no time should deep cultivation be practiced, as the roots are to be found very near the surface of the soil. If a mulch is used no hand cultivation will be required, either along the side or between the plants in the row, except to pull any weeds that may spring up. Where no mulch is used it will be necessary lightly to stir the surface with a wheel hoe or iron rake, to prevent a crust being formed after each rain or watering. Keep the surface of the soil smooth and in no case allow lumps of earth to remain near the plants.

Blanching.—In its original wild state the stems of celery are tough, full of woody strands, of a rank flavor, and green in color, being similar to the outside stems or trimmings of our present varieties. The object of blanching is to secure leafstalks free from woody strands, crisp and tender, and without the rank flavor found in those that are green. Of the cultivated plant there are two classes of varieties, the large-growing, or giant, and the dwarf sorts. These are again divided into those which must be blanched by excluding all the light and those which are in a measure self-blanching. Of the former the Giant Pascal variety is a type, and of the latter the Golden Self-Blanching variety is a good illustration.

Blanching is accomplished by the same general method that is employed for destroying the coloring matter in any plant tissue, that is, by excluding the light and allowing the growth to proceed in the dark. The particular method to be adopted must be determined largely by the time when the crop is to be used. If for early use or marketing, the blanching must be completed where the plants are grown; but if the celery be for winter use the blanching may take place after the crop has been removed from the field and placed in storage. In fact, it is best to blanch as little as possible before storing when the product is to be kept until late, as the keeping qualities are better while it is unblanched. When planting for early use it is necessary to choose one of the self-blanching varieties, such as may be conveniently blanched by the use of boards or other similar means.

For early blanching on a small scale, such as would be employed on the farm or in the garden of the amateur horticulturist, there are several methods. One of the most common is by means of boards placed on edge along each side of the row.

After the boards are in position it is a good plan to run a celery hiller between the rows and to throw a little soil against the lower

edges of the boards to close any openings that may result from the uneven surface of the soil.

Two or three weeks' time will be required to complete the blanching of the early varieties, and the boards must be kept in position until the crop is removed from the ground, after which they may be used again two or three times during the season. If the celery is allowed to remain in the boards too long after it has reached a marketable stage, it loses in weight and flavor and is liable to be injured or even destroyed by the attacks of blight. This is especially true during the earlier part of the season, when the weather is warm. At the end of the season the boards should be piled flat, with strips inserted at every fourth or fifth course, and the whole pile roofed over to shed off rain; treated in this manner they will last from ten to twelve years.

Perhaps the most satisfactory way of blanching early celery on a small scale is by means of ordinary farm drain tiles of about 4 inches inside diameter, placed over the plants after they have become almost fully grown. To facilitate the work of placing the tiles over the plants, some of the outside leaves should be pulled away and the main part of the plant loosely tied together by means of a soft string, or, better, with what is known as paper twine, being a string made by twisting a strip of soft paper. This string will lose its strength as soon as it becomes wet, and will offer no resistance to the further growth of the plant. If the common, unglazed tiles are used the evaporation from their surface has a tendency to keep the plant cool during the heat of the day, and a very crisp and tender product is the result. This method of blanching is desirable also on account of its cleanliness, as celery treated in this way will need very little washing before marketing.

The most common method for blanching celery on a small scale is that of banking with soil, and it is by this means that the finest flavor can be obtained. Where the plants are set in single rows the soil can often be partially thrown up by means of a plow, or, better, by a celery hiller. Before the plow or banking machine is used a small quantity of dirt must be placed around the plants by hand to hold them in position while the earth is being thrown around them. This may also be accomplished by tying up the plants with paper twine, as previously recommended for use in connection with tiles.

Storing.—The plan usually adopted where but a small quantity of celery is to be stored for winter use is to bank up with earth and cover the plants where grown. Place enough earth around the base of the plants to hold them in good form, and then allow them to remain without any further banking as long as there is not danger of a hard frost. Celery may be safely stored in cellars provided the temperature is kept low and plenty of ventilation maintained. The warmth and dampness of the ordinary cellar have a tendency to cause the celery to decay, but these conditions can frequently be overcome. Celery will readily absorb any odor that may be present in the atmosphere of the storage place, and care should be taken to provide sanitary conditions. When storing in a cellar, the plants

should have most of their roots attached, and a bed of moist sand in which to set them should be provided.

Preparing Celery for Market.—In preparing it from the rows where grown, it is not necessary to remove the entire root from the earth, but it may be cut off just below the surface of the soil by means of a stiff knife. Remove the outside leaves and trim the root evenly, pack in boxes, and load on the wagon for removal to the washing house. The blanching boards should not be removed till necessary, and the trimmed celery must not be allowed to lie exposed to the sun or wind for any length of time. It is well also to have a piece of canvas to protect the celery while it is on the wagon on the way to the washing house. In marketing from the trenches the process is practically the same as from the rows, except that the celery is already loosened from the soil and the roots can be removed more easily. Upon reaching the washing room the celery is placed upon a rack consisting of wooden slats over a large trough and subjected to a spray of cold water to cool it and to remove the adhering soil. After washing, it is allowed to drain; then it is tied in bunches of 12 or more plants each, according to the size. The bunches are packed 6 in a box for first-grade celery and 8 or 9 for second or third grades. These boxes should be practically air-tight, and a lining of paper should be placed in them before packing the celery, or each bunch should be wrapped separately. The celery should be nearly dry before it is placed in the boxes, and throughout the entire handling must be kept as cool as possible.

Sanitary Conditions.—It is essential that the celery should be washed in pure water to prevent the transmission of disease germs. Any germ, such as that producing typhoid fever, which is found in contaminated water, is readily carried to the digestive system of the consumer, and may or may not produce an attack of the disease, according to the strength of the person to resist it. The washhouse and its surroundings should be kept clean and free from any decomposing materials. Shippers and dealers alike lose sight of the fact that the edible portion of celery is constantly being exposed to the contaminating effects of dirty wagons, unclean cars, and dusty markets. Many persons have discontinued the use of celery on account of the unclean condition in which it is served. This statement holds good for all vegetables that are served in the raw state, but it is especially applicable to celery.

Estimates of Returns.—Anyone contemplating making a start in celery growing will do well to first investigate the market prospects, and unless satisfactory shipping arrangements can be made beforehand the crop should be planted only on a small scale for one or two years, until a local trade can be established. It is fair to estimate a return of 1,500 dozen from 1 acre, and this should bring 25 cents per dozen, at the lowest average estimate; this will yield a gross income of $375 to the acre, leaving a net balance of $125 to cover the interest on the investment and the profit. As a matter of fact, the growers who are making a success of celery raising—and many are doing so—receive a net profit of $100 an acre over and

above the interest on the investment. On the other hand, hundreds of acres are grown annually which do not much more than pay expenses, but this is due to the fact that the soil has become exhausted and the product is consequently undersized and inferior.—(F. B. 255, 282; Cornell E. S. 132; Colo. E. S. 144.)

CETEWAYO, OR ZULU, POTATOES.

The Cetewayo, or Zulu, potato, a wild variety of *Solanum tuberosum* found in Africa, is sometimes grown as a garden vegetable for its flavor and novelty. It has practically the same percentage composition as the ordinary potato. When cooked, the flesh is purple in color, but when brought in contact with vinegar, as in salads, it turns red.—(F. B. 295.)

THE CHAYOTE.

The chayote suggests the cucumber rather than any other of the cultivated plants of the same family, but is a larger and more vigorous plant, climbing widely by means of numerous branched tendrils. When grown under ordinary garden conditions the cultural requirements of the chayote may be said to be two in tumber: (1) A somewhat sheltered situation and (2) something to climb upon. While the vine will not refuse to grow without these advantages, the results will not be satisfactory. Like many climbing plants, the chayote is very susceptible to injury from the wind, while, unlike many Cucurbitaceae, it does not seem to take kindly to creeping upon the ground, at least in the Tropics. In the different parts of the world the chayote has been found to grow upon a great variety of soils, though it is generally considered to thrive best in a loose sandy or loamy substratum, providing sufficient humus or other fertilizing material be at hand. Although it has been found possible to secure plants from the seed when planted alone, or even from the embryo when carefully extracted from its seed coats, it is the universal practice to plant the entire fruit. The fruit should be gathered before fully matured, because of the tendency to germinate. It is like the cucumber, edible at any stage of growth, and may be picked when large enough. The chayote is a good shipper and may be shipped in bulk in vegetable crates, wrapped and well packed; cold storage will not be necessary. —(Dept. Ag., Div. of Botany 28; P. Rico A. E. S. 7).

CHERVIL.

Under the name of chervil two distinct plants, known as salad chervil and the turnip-rooted chervil, are cultivated. The seeds of the salad chervil are sown in spring and the crop will thrive on any good garden soil. The seeds of the turnip-rooted chervil should be sown in the early autumn, but they will not germinate until the following spring. The edible part of this plant is the root, which somewhat resembles the carrot and is used in the same manner. The leaves are used the same as parsley for garnishing and in flavoring soups.—(F. B. 255.)

CHICORY.

Chicory is grown for two or three purposes. The root of this plant is the common adulterant of coffee, and large quantities are used for this purpose. The commercial growing of chicory is con-

fined to a few sections, as the crop will not thrive on every kind of soil. A deep, rich loam, without excessive amounts of clay or sand, is desirable, and soil that is not too rich in nitrogenous matter is best suited to the production of roots. The roots are frequently placed in soil under a greenhouse bench or in a warm cellar and covered with a foot or more of straw, or with a light covering of straw and then several inches of warm manure. Under this covering the leaves will be formed in a solid head, which is known on the market as witloof. Chicory has run wild in some parts of the country and is considered a bad weed. The handsome blue flowers, which are borne the second season, are very attractive. As a pot herb chicory is used like spinach, but the leaves should be boiled in two waters to remove the bitter taste. As a salad the roots are dug in the autumn and planted in cellars or under a greenhouse bench, where they produce an abundance of blanched leaves, which are eaten raw. The blanched leaves are also boiled and used as greens.—(F. B. 255; U. Idaho E. S. 10.)

CHILE.

The chile is used in many different ways and it is quite an important article of food among the Spanish speaking population in the Southwest and in Mexico. It is eaten both in the green and ripe state. It may be grown on ridges or in level plats. The former method is the more common in New Mexico. In the spring after the ground has been plowed and leveled (the plowing of the land can be done in the fall or winter) and just a little before planting the ridges are made. These ridges may vary in height from 8 to 12 inches. It is better to irrigate the ridges before planting, though this is not always done. The object of irrigating before planting is to get the water mark on the side of the ridges and to settle the newly plowed soil somewhat. As soon as the soil is dry enough so it can be worked, which is generally from four to seven days, the seed is planted usually on one side of the ridge and just above the water mark. The seed is planted by hand in hills about every two feet in the row. The chile does not stand freezing weather, though it will stand a little more cold than tomatoes. For the convenience of intending chile growers the following table which gives the number of hills per acre at different distances has been prepared:

Distance.	Number of Hills per Acre.
3½ feet between rows x 2 feet in the row	6222
3½ feet between rows x 2½ feet in the row	4978
4 feet between rows x 2 feet in the row	5445
4 feet between rows x 2½ feet in the row	4356

Planting.—The seed is planted on the side of the ridge, when the ridge method is practiced. The southern exposure of the ridge is always preferable since this is usually warmer and the germination, other factors being uniform, is quicker. If level culture is practiced there is no choice of exposure. Whatever method of planting is followed care should be taken not to bury the seed too deeply. As a general thing the seed should not be deeper than three-fourths of an inch to an inch and a half. Shallower planting, if the moisture is kept normal, will give quicker and better germination. More seed is

Eaton Raspberry.

required per acre when the planting is done by hand on the ridges than when it is drilled with a garden drill in plats.

Thinning.—Chile started from seed planted in the field must be thinned to one or three plants to the hill. When the chile has been thinned out properly the plant or plants in the hill branch out considerably and produce a heavier and better crop. If too many plants are left to the hill there is a marked tendency for the plants to grow too tall and more or less top heavy. The chile is thinned out when about 3 to 5 inches high. If a good germination takes place it is more difficult to thin the chile, because there are more small plants to the hill to be pulled out. Care should be had in selecting the strongest plants in the hill and in injuring as little as possible the roots of those which remain. While the common way of growing chile is to plant the seed out in the field in the spring, it can also be grown by starting the plants in cold frames early in the season and transplanting to the field as soon as danger of frost is over.

Irrigation.—After the irrigations to get the crop started have been given, the frequency of the subsequent irrigations depends upon the weather and soil conditions, and for that reason no specific statement can be made just when and how often the chile should be irrigated. One thing, however, is important to keep in mind, and that is that the chile plant keeps bearing as long as it is growing. If the growth should be checked by the lack of irrigation the plant stops bearing and the blossoms and the very small pods are likely to drop off. The grower himself should study his local conditions and decide for himself when and how much to irrigate. While the chile plant resists considerable drought, at the same time, it should not be allowed to suffer from the lack of irrigation. When the chile is grown on ridges the space between the ridges should be allowed to fill with water almost up to the plant. If the water is simply turned in and allowed to rush down the furrow to the other end the ridges will remain practically dry, necessitating frequent irrigations to keep the plants from suffering. In irrigating the chile on ridges always aim to hold the water long enough in the furrow for the ridges to get fairly well soaked through. In the level plat the irrigation is more simple and the soil around each hill gets wet sufficiently while the water is running down to the end of the plat. When the plats are quite long and are made up of a series of squares as soon as each square is filled with water the border, dividing that square from the next one, is cut and the water rushes into the next square which is treated the same as the one before.—(N. Mex. Col. Ag. and Mech. Arts 67.)

CHIVE.

This is a small onion-like plant having flat, hollow leaves which are used for flavoring soups. The chive rarely forms seeds, and it is propagated by the bulbs, which grow in clusters. The leaves may be cut freely and are soon replaced by others.—(F. B. 255; S. Dak. E. S. 68.)

CITRON.

The citron is a type of watermelon with solid flesh which is used

for preserves and sweet pickles. The rind of the watermelon is frequently substituted for citron. The cultivation of the citron is the same as for the watermelon.—(F. B. 255; U. Idaho E. S. 10.)

COLLARDS.

The culture and uses of collards are the same as for cabbage and kale. Collards withstand the heat better than either cabbage or kale, and a type known as Georgia collards is highly esteemed in the Southern States. Collards do not form a true head, but instead a loose rosette of leaves, which, when blanched, are very tender and of delicate flavor.—(F. B. 255; U. Idaho E. S. 10; P. Rico A. E. S. 7.)

CORN SALAD.

Corn salad is also known as lamb's-lettuce and fetticus. Sow the seed during the early spring in drills 14 to 18 inches apart and cultivate the same as for lettuce or mustard. For an extra early crop the seed may be planted during the autumn and the plants covered lightly during the winter. In the Southern States the covering will not be necessary and the plants will be ready for use during February and March. The leaves are frequently used in their natural green state, but they may be blanched by covering the rows with anything that will exclude the light. Corn salad is used as a salad in place of lettuce, or mixed with lettuce or water cress. The flavor of corn salad is very mild, and it is improved by mixing with some other salad plant for use. It is also boiled with mustard for greens.—(F. B. 255.)

CRESS.

Under the name of cress there are two forms, the water cress and the upland cress. The upland cress, sometimes called peppergrass, is easily grown from seed sown in drills a foot apart. As the plants last but a short time, it will be necessary to make a sowing every few days if a continuous supply is desired.

Water cress can be grown all the year in small open ditches containing running spring water. It is best and most easily produced in water from rather warm springs in limestone regions. A sufficient supply for family use can be grown in a small spring-fed brook, and the plants may be started either from small pieces of plants or from seed. Cress is used in salads, to which it imparts a pleasant pungency. —(F. B. 255; U. Idaho E. S. 10; P. Rico A. E. S. 7.)

CUCUMBERS.

Soil.—The soil best adapted to the cultivation of cucumbers in the open is a light sandy loam, one which responds quickly to temperature and fertilizer. Such soils are prepared early in the season and thrown into gentle undulations, so as to produce slight ridges upon which to plant the seed to insure good surface drainage.

Fertilizers.—The soil for cucumbers should be made very rich by the annual application of heavy dressings of stable manure to be incorporated with the soil. During the time it is not occupied by cucumbers or lettuce, cowpeas are frequently grown upon the area and turned under prior to planting a fall crop of lettuce. In addition to this, liberal applications of a fertilizer carrying a considerable percentage of nitrogen are employed.

Planting.—There are almost as many methods of planting

cucumbers as there are growers. Some plant in hills the standard distance of 6 feet apart each way; others plant in hills 6 feet apart in one direction and 2 or 3 feet apart in the row, while others plant in drills or broad belts 6 feet apart and chop out the plants to stand about a foot apart in the row after all danger from insect depredation has ceased. The methods which seem most economical under the conditions at hand will of course be adopted by the grower. In outdoor culture the cucumber is frequently used as a companion crop to other crops, like beans. Beans being of rapid growth come on quickly and form a partial protection or wind-break for the young cucumber plants. When arranged in this way, cucumbers are planted in drills or in hills 6 feet apart and a row of beans is placed between two rows of cucumbers, a method which insures a very complete and satisfactory use of the ground. The quick maturity of the beans allows them to be harvested and entirely removed from the area before it is required for the cucumbers.

Harvesting.—Cucumbers intended for pickling purposes are harvested when they have attained a length of from 2½ to 5 inches. Because such cucumbers are bought by weight it will readily be seen that the small-sized pickles are less profitable to the grower than the larger ones, and in order to secure them before they have attained an unsalable size it is necessary that the picking be repeated at frequent intervals, as cucumbers grow rapidly and a delay of twenty-four to forty-eight hours in harvesting would render many of them unsalable. It is therefore necessary to have regular intervals to harvest certain areas of the patch and to continue this routine throughout the bearing season. Another point which is of prime importance in the management of the cucumber patch is that none of the fruits be allowed to come to maturity. The ripening process, which means the development and maturing of the seeds, produces a heavy strain upon the growing plant, the life and yield of the plant being in proportion to the number of fruits which are allowed to ripen. If no fruits are allowed to come to maturty the plants will remain green and in an active vegetative condition longer and will produce a much larger aggregate number of fruits.

Dill Pickles.—Dill pickles, which are much prized and command the highest price among pickles, can be made from fresh cucumbers as they come from the vines, or from vat stock which has been carried for some time at the salting station.

Cucumbers Grown in Cold Frames for Market.—Soil for use in cold frames should be a well-enriched sandy loam of the type of the usual sandy loam. If it can be dark in color, this is an advantage. If normally light, the color can be changed by the addition of muck or by incorporating well-decomposed stable manure with the surface soil. A dark color is of some advantage in helping to raise the temperature in the frames under the glass.

Watering.—Since the glazed sash prevent the soil beneath them being moistened by natural means—that is, by rain or dew—it is necessary that means be provided for watering or irrigating the plants. This can be done by arranging pipes upon the surface of

the ground or at a convenient height overhead, so as not to interfere with cultivation, from which water can be drawn to sprinkle the surface of the beds at desired intervals and as the plants may require. The work of watering should, however, be very carefully done. The same general precautions necessary for the care of plants in cold frames should be observed—that is, to do the watering in the morning on bright days only, when air can be admitted and when the sun will soon dry the moisture from the leaves of the plants. In this way much can be done to protect the plants from injury from such diseases as the damping-off fungus and mildew.

Ventilation.—Besides the precautions to be observed in watering plants in cold frames, extreme care is necessary to give the plants sufficient air to keep them in a healthy condition. If the atmosphere is allowed to become close and very hot, the plants will be weakened and thus rendered more susceptible to the attacks of plant diseases.

Forcing Cucumbers Under Glass.—Forcing is a technical term used by gardeners to designate the growing of plants out of their normal season under an artificial environment. The cucumber is one of the few garden plants which lend themselves to this manner of cultivation in addition to their more extensive cultivation in the open ground. Under the stimulus of forcing work, two distinct types of cucumbers have been developed. These are recognized in the trade as the English type and the American type. The English type is purely a product of forcing-house conditions, as the climate of England is not congenial to the growth and development of the cucumber in the open. The American type of cucumber is primarily a product of field conditions, and the few varieties which have been developed to meet the requirements of the forcing house are simply modifications of the existing field or outdoor forms. The English type of cucumber is a long, cylindrical, uniformly green fruit, with few seeds and a very fleshy seed cavity; in fact, the normal seed cavity of the forced cucumber is almost entirely wanting. The triangular shape characteristic of the normal outdoor cucumber has been lost, and the cylindrical outline almost perfected. There is considerable difference in the size and length of the various English varieties of cucumbers. The American type of cucumber is primarily grown in the field, the product to be used either for pickling or for slicing. Forcing cucumbers in America is confined to those varieties which produce large fruits suitable for slicing. Only three or four of the better and larger field varieties are adapted to this purpose. Notable among these is the White Spine, the Arlington White Spine being the variety which has been especially developed for forcing. The Long Green, or a modification of it, is also sometimes used, but aside from these two varieties there are few that ever find their way into the forcing house. Such varieties as the Boston Pickling, Chicago Pickling, and the cluster varieties in general are not adapted to forcing purposes. The forcing of cucumbers presupposes that an adequate forcing house or greenhouse is at hand for such work. The chief desideratum in a forcing house for cucumbers is a maximum amount of light, sufficient headroom, and adequate radiation to maintain a temperature

varying from 65° to 85° F. The amount of radiation will, of course, depend upon the style of heating employed, whether steam or hot water, and upon the location of the greenhouse, whether at the north or the south; the outside temperature determining to a considerable extent the amount of radiation required in the house to maintain a given degree of heat.

Propagation.—There are a number of methods of propagation followed by successful cucumber growers, all of which have some advantages. Three of the more common practices are as follows: (1) To plant the seeds of cucumbers in the soil of the bench where the plants are to grow and mature; (2) to plant the seeds of the cucumbers in 3-inch or 4-inch pots filled about half full of soil and after the seeds have germinated and the hypocotyl or stem of the seedling has elongated to fill the pots well up to the seed leaves with soil; and (3) to plant the seeds in cups similar to those used for harvesting strawberries, except that the cups for this purpose are usually made of Georgia pine. In the first case, where the seeds are planted directly in the soil on the benches, cucumbers are usually employed as a crop to follow lettuce, seeds being planted in the lettuce benches before the crop is entirely removed, heads of lettuce being taken out at proper distances to allow for the correct spacing of the cucumber plants, and the seeds of cucumbers planted in the areas so left. In the other two cases the rearing of the plants for forcing purposes can be carried on in a small house especially designed for this purpose or in a general propagating house, thus obviating the necessity of heating and maintaining normal conditions in the growing house during the period previous to which the plants begin to run.

Planting on the Benches.—As soon as the plants show well-developed runners and are 10 to 12 inches long they should be placed in their permanent position upon the greenhouse benches. Plants grown in pots must be carefully removed from these receptacles to the bench, but those grown in the wooden cups above referred to can be planted, cup and all, in the soil of the bench. The utmost care should be exercised to keep the plants of the cucumber growing rapidly at all times. If cucumbers receive a severe check or are placed under conditons which are not entirely congenial to them, they are liable to become dwarfed and stunted, and as soon as vigorous growth ceases they become the prey of the melon aphis, mildew, and other pests and diseases which are so annoying to growers of cucumbers under artificial conditions.

Distance to Plant.—After the plants have attained a height of 10 or 12 inches and are in a vigorous growing condition they should be placed about 15 or 18 inches apart in single rows upon the side benches of the greenhouse, which are normally 3½ feet wide, or if planted on 8-foot benches they should be planted about 10 or 12 inches from the edge of the bench and 15 to 18 inches apart and parallel with the edge of the bench. In the broad benches, where more than a double row can be carried, plants can be set about 18 inches apart and in rows about 2 feet apart. A satisfactory plan for an 8-foot bench will be a row parallel with and 10 inches from each edge

of the bench and a double row 18 inches apart through the middle of the bench. It is well, however, to allow as much space as possible. The cucumber is a rank-growing plant and many side branches will develop if sufficient space is allowed.

Training the Plants.—As soon as the plants show a tendency to run they should be trained so as to keep them from becoming unduly tangled and in order to fill all the space upon the trellis. Galvanized wires No. 16 can be run lengthwise of the house and stapled to the supports, which should be placed about 6 feet apart. Upon side benches which are elevated it will be necessary to train the cucumbers to the framework of the greenhouse. For this purpose screw eyes about 8 inches in length can be placed in the sash bars at intervals of 4 or 5 feet and the parallel wires to which the vines are to be tied stretched 12 inches apart lengthwise of the house through these screw eyes and firmly fastened at the ends. The vines should then be loosely tied to the supporting wires with raffia or soft cotton yarn. When the fruits become heavy, as in the case of the English varieties, it will become necessary to truss them to prevent their weight breaking the vines. Heavy fruits will cause the supporting wires or bands of raffia to break or girdle the vines unless they are supported independently. The American varieties seldom attain sufficient size to require this precaution. Fruits of these varieties as soon as they are 8 to 10 inches in length and 2 inches in diameter are harvested for market. The vines are usually sufficiently strong to withstand the weight of fruit of this size.

Pollination.—The cucumber, like the other members of the gourd family to which it belongs, bears two kinds of blossoms on widely separated parts of the plant. The staminate or nonfruit-bearing flower is the first to appear and is in general borne near the base of the plant. The pistillate blossom with the embryo cucumbers at its base appears later and is borne near the extremity of the newly forming and rapidly growing shoots. Since these flowers are normally produced in this way, it is necessary that a transfer of pollen be made from the staminate to the pistillate flowers throughout the agency of insects or by other artificial means. Under greenhouse conditions and at the time of year that the cucumber is forced it is necessary to provide for pollination. In small establishments this work can be done by hand. The staminate blossoms are removed, the petals turned back so as to allow the anthers to project, and the pencil thus produced is then thrust into the cup of the pistillate flower in such a way as to distribute pollen upon the stigma of the pistillate flower. In large establishments where hand pollination is out of the question a colony of honey bees is placed in each house to accomplish the work.—(F. B. 254, 255; Mass. Ag. Col. E. S. 87; Iowa Ag. Col. E. S. 47.)

DANDELION.

Sow the seed of dandelion in spring in drills 18 inches apart, covering it one-half inch deep. Thin the plants to about 12 inches apart and give good clean cultivation throughout the summer. In the colder parts of the country it may be desirable to mulch slightly

during the winter to prevent the plants heaving out of the soil. Early the following spring the plants will be ready for use as greens, but they are greatly improved if blanched by setting two boards in the forms of an inverted letter V over the row. The blanching not only makes the leaves more tender but destroys a part of the bitter taste. Dandelion greens should be boiled in two waters to remove the bitterness.—(F. B. 255-68; S. Dak. 68; U. Id. E. S. 10.)

DILL.

Grown as Fennel which it greatly resembles, both being well known herbs used for flavoring pickles, and both being of unsurpassed hardiness.—(Mich. E. S. 20.)

EGG PLANT.

This delicious vegetable is not so much cultivated in our gardens as it should be. This has arisen largely from the difficulty of getting the plants from seed in the open ground. If you have no greenhouse, hot-bed, nor frame, it will be best to buy the plants at setting- time from some one who grows them early in pots. Plants pulled from a bed are seldom worth planting, as the egg plant is slow to recover from a serious check.

Kind of Soil.—A sandy loam will be found excellent soil; this should be well drained and have a moist subsoil. Land that has been drained, if all other conditions are proper, will make an excellent field. This plant is a deep feeder, so that the land should be plowed as deeply as possible. A new field should not be taken, while one might succeed, the chances are not so good as on an old and well-tried piece of land. Be sure that all rubbish and matter that could interfere with cultivation has been removed. Fertilize the field broadcast; there is little or no danger of the plants failing to get the food if it is in the soil. The best way is to apply the fertilizer just before plowing the field, and then apply a smaller amount where the plants are to stand; work the fertilizer in well a week or two before setting out. Lay the land off into rows four feet apart, and set the plants three or four feet apart in the row. At convenient distances a row may be skipped to make a road to gather the crop. After the crop has been planted there is little or no use for a hoe; the plow can and ought to do the work. No weeds should be allowed to show more than the seed leaves, and the ground should be kept mellow enough to let a person sink nearly to the ankles in dry times. When the fertilizer has been applied properly the roots will seek the deeper soil, and the ordinary horse cultivator will not reach them at all. Eggplant raising pays best under high cultivation. By replenishing the fertilizer, plants may be kept in bearing until frost kills them in the fall, but it will be found more profitable to renew the field, if a summer or fall crop is desired.—(U. Id. E. S. 10; N. C. E. S. 132; Fla. E. S. 31; F. B. 255; Iowa E. S. 47.)

ENDIVE.

The endive is a form of chicory. Sow the seeds thinly in drills, and when the plants are well established thin to 8 inches. Water and cultivate thoroughly in order that a good growth of leaves may be made. When the leaves are 6 to 8 inches in length draw them

together and tie them so the heart will blanch. The leaves should not be tied up while wet or decay will follow. The heads should be used as soon as blanched. For winter use sow the seeds rather late and remove the plants, with a ball of earth adhering to the roots, to a cellar or cold frame, and blanch during the winter as required for use. Endive is used as a salad at times of the year when lettuce and similar crops are out of season.—(F. B. 255; U. Id. E. S. 10; S. Dak. E. S. 68.)

FENNEL.

Cultivated for the sweet aromatic foliage and fruit is an herb used for flavoring pickles.—(Mich. E. S. 20.)

GARLIC.

Garlic is closely allied to the onion, but will remain in the ground from one year to another if undisturbed. Garlic is planted by setting the small bulbs, or cloves, either in the autumn or early spring. The culture is practically the same as for the onion. The bulbs are used for flavoring purposes.—(F. B. 255.)

GINGER.

Ginger, the underground root stock of *Zingiber officinale,* is perhaps most commonly used dry as a spice, though the fresh root or green ginger is common in autumn, being used in pickle making, preserving, and in other ways. The young and tender ends of the branching root or rhizome, called ginger buds, are the most delicate portion as regards both texture and flavor. Large quantities of ginger root are preserved in rich sugar syrup, the round stone jars of "Canton ginger" being an old-fashioned confection which is still much prized. The crystallized or candied ginger is even more common and is frequently served as a sweetmeat, and is also used in making deserts of various sorts.—(F. B. 295.)

HERBS.

To this group belong a number of plants hardly recognized as vegetables in the common use of the term, yet of sufficient importance to entitle them to a corner in the family garden. The herb garden or "patch" is too often considered a worthless gift or fashion handed down from grandmother's day. In every well ordered garden there should be a few of the common herbs. The same conditions concerning care, cultivation, etc., will answer for all. The site selected should be out of the way so that it may not be disturbed. As the bed is to be permanent it should be made fertile and cultivated deeply. In sowing classify according to whether they are annuals or perennials. The plants may be grown from seed but whenever possible, propagation by root division is much more easy and certain. In autumn before frost the leaves and stems of those desired for winter use should be gathered, tied in small bunches and hung up to dry in an airy room. Where the seed is desired, it should be allowed to ripen and harvested.—(U. Id. E. S. 10; S. Dak. E. S. 68; N. C. E. S. 132.)

ICE PLANT.

This plant (*Mesembryanthemum cristallinum*) gets its name from the crystalline ice-like covering of the leaves. In hot countries

the leaves are used as a salad or boiled the same as spinach.—(S. Dak. E. S. 68.)

HORSE-RADISH.

This plant will thrive best in a deep, rich soil, where there is plenty of moisture. The rows should be 3 feet apart and the plants 12 to 18 inches apart in the row. Tops cut from large roots or pieces of small roots are used for planting. A comparatively few hills of horse-radish will be sufficient for family use, and the roots required for starting can be secured of seedsmen for 25 or 30 cents a dozen. This crop will require no particular cultivation except to keep down the weeds, and is inclined to become a weed itself if not controlled. The large fleshy roots are prepared for use by peeling and grating. The grated root is treated with a little salt and vinegar and served as a relish with meats, oysters, etc. The roots should be dug during the winter or early spring before the leaves start. After being treated with salt and vinegar the grated root may be bottled for summer use. As this has always been considered strictly a cold-weather plant, is would seem useless to try to grow it in Porto Rico, but, as it gave very favorable results at this station, it can no doubt be produced for local consumption. It is practically unknown in Porto Rico, but most people acquire a taste for it, and foreigners, who are used to it in their native country, will find it very gratifying that they can grow it here. In the North it thrives in any soil from a light sand to a heavy clay, but prefers a medium heavy loam. Here it grows luxuriantly in heavy clay but may not do so well in sand. It is planted from cuttings of the lateral roots, which should be from 4 to 6 inches long and planted at a distance of 12 to 15 inches in rows 24 to 30 inches apart. Root cuttings can be obtained either in spring or fall from any seed firm, and these should be planted when received. The roots can be dug when large enough for use or can be left in the ground until wanted.—(F. B. 255; U. Id. E. S. 10; P. Rico E. S. 7.)

KALE, OR BORECOLE.

There are a large number of forms of kale, and these are thought by some to be the original type of the cabbage. Kale does not form a head and has convoluted leaves and thick leaf stems. It is cultivated the same as cabbage, but may be set somewhat closer. This crop is very hardy and will live through the winter in the open ground in localities where freezing it not too severe. The flavor of kale is improved by frost. Kale is used for greens during the winter, and as a substitute for cabbage.—(F. B. 255; N. Car. E. S. 132; U. Id. E. S. 10.)

KOHL-RABI.

Kohl-rabi belongs to the same class as cabbage and cauliflower, but presents a marked variation from either. It is, perhaps, half-way between the cabbage and turnip, in that its edible part consists of the swollen stem of the plant. For an early crop, plant and cultivate the same as for early cabbage. For a late crop or for all seasons in the South the seed may be sown in drills where the crop is to be grown and thinned to about 8 inches apart in the row. The rows

should be from 18 to 36 inches apart, according to the kind of cultivation employed. The fleshy stems should be used while they are young and quite tender. Prepare kohl-rabi for the table in the same manner as turnips, which it very much resembles when cooked. —(F. B. 255; U. Id. E. S. 10; Mich. E. S. 20; N. C. E. S. 132; La. E. S. 90.)

LEEK.

This plant belongs to the same class as does the onion, but requires somewhat different treatment. Leeks can be grown on any good garden soil and are usually sown in a shallow trench. The plants should be thinned to stand about 4 inches apart in the row and the cultivation should be similar to that for onions. After the plants have attained almost full size the earth is drawn around them to the height of 6 or 8 inches to blanch the flshy stem. The leek does not form a true bulb like the onion, but the stem is uniformly thick throughout. Leeks are marketed in bunches like young onions, and they may be stored the same as celery for winter. Leeks are used for flavoring purposes and are boiled and served with a cream dressing the same as young onions.—(N. Car. E. S. 132; La. E. S. 90; F. B. 255.)

LETTUCE.

This crop attains its best development in a rich sandy loam in which there is plenty of organic matter. Lettuce thrives best during the early spring or late autumn and will not withstand the heat of summer. In order that the leaves may be crisp and tender, it is necessary to force the growth. The usual method of growing lettuce for home use is to sow the seeds broadcast in a bed and remove the leaves from the plants as rapidly as they become large enough for use. A much better method is either to thin or transplant the seedlings and allow the plants to form rather compact heads and then cut the entire plant for use. In the Southern States the seeds may be sown during the autumn and the plants allowed to remain in the ground over winter. At the North the seeds may be sown in a hotbed or cold frame and the seedlings transplanted to the open ground, or the seeding may be in rows in the garden and the plants thinned to 5 or 6 inches in the row. Lettuce may be grown in rows about 12 inches apart. In order to produce crisp and tender lettuce during the summer months, it may be necessary to provide some form of partial shading.—(F. B. 255; N. Y. E. S. 208; N. Car. E. S. 147; Tenn. E. S. 2; Purdue Ind. E. S. 66 and 84; Kas. E. S. 70.)

LLEREN (*Calathea allouya*).

This vegetable, although cultivated in Porto Rico for a long time, is not extensively known. The plant at a cursory glance resembles a canna. The edible tubers, which are formed in great profusion, can be eaten boiled like potatoes; but, unlike potatoes, they do not become soft, but appear hard and crisp after prolonged boiling. Lleren somewhat resembles boiled sweet corn in taste, and most people pronounce it delicious without needing to acquire a taste for it. The best soil for lleren is a rich, moist, well-drained loam, which is usually benefited by an application of wood ashes or sulphate

of potash; an excess of nitrogen causes the production of large tops and few tubers. The stools or roots immediately adhering to stalks are the parts used for propagating; the tubers will not germinate. Lleren should be planted at intervals of 2 feet in rows 4 feet apart, and cultivated like any other vegetable. It requires ten to fifteen months to mature tubers, which are 3/4 to 1 inch in diameter, and may be harvested at any time when large enough, but can be left in the ground for a long time without spoiling. It is a good shipper and if introduced into the northern market it would soon create a demand.—(P. Rico E. S. 7.)

MARTYNIA (*Unicorn Plant*).

The curious, long beaked fruit is used for pickles. The plants are quite hardy and ornamental, the fruit being no less conspicuous for its odd shape than the large wax-like flowers of whitish color with purple and yellow spots.—(Mich. E. S. 20.)

MELON—MUSK.

Soil and Location.—The soil for muskmelons must be well drained and contain an abundance of humus and readily available plant food. If these conditions are met, it matters little what the particular type of soil may be. A knoll or ridge sloping gently to the south and protected by timber on the north and west furnishes an ideal site for melons. Such a location will usually produce earlier melons than a north or west slope and is better than a level area because the soil dries out more quickly after a rain, thus permitting more timely tillage in a wet season, and resulting in the production of melons of better flavor. It is only in dry seasons that low, flat land, unless thoroughly tile-drained, produces good melons. The condition of the soil in reference to its supply of humus has a marked influence upon the welfare of the melon crop. Because of its abundance of humus, newly cleared timber land is well adapted to melon culture, but is difficult to work on account of the stumps and roots. Land slightly deficient in humus can be put in condition for growing melons by plowing under a clover sod, or a crop of cowpeas or rye, or a coat of manure applied broadcast. If melons are to be grown as one of the crops in a regular rotation, they should constitute the crop immediately following the leguminous crop designed to add humus and nitrogen to the soil. In regions where winter wheat and clover are grown, a rotation of wheat, clover and melons is highly satisfactory. Another good rotation would be: oats, clover, melons, corn. In regions where clover does not thrive and wheat and oats are not grown, a rotation of corn, cowpeas, and melons may be employed, or the rotation extended by seeding to grass after the melons are harvested. Even with careful attention to rotation and the incorporation of humus by plowing under catch crops or manure, ordinary farm land—including good corn land—is not sufficiently rich to produce a satisfactory crop of melons without the use of fertilizing material in the hills. It is only on garden soil that has been made exceedingly rich by repeated applications of manure, that it is wise to attempt to grow melons without special treatment of the hills.

Manure for the Hills.—The manure for use in the melon hills

is ricked up in the fall in long low piles, about eight feet wide and two or three feet deep. The sides of the pile are made as nearly perpendicular as possible and the top is flattened so that rains will soak in instead of running off. Sometimes a layer of dirt about three inches deep is placed on top of the manure to help retain the moisture. Early in the spring, work is commenced on the manure to put it in condition for use. The pile must be cut down and the manure turned and mixed until it is thoroughly decomposed and of fine texture. Formerly this work was done by hand with a fork, and entailed a large amount of labor. Now some of the large growers do all this turning of the manure with a disk and plow. The pile is worked three or four times at intervals of one or two weeks.

Time of Planting.—The melon is a warm season crop, and unless the soil is warm and the weather favorable the seeds will not germinate nor the plants grow. It is therefore usually unwise to plant in advance of the normal season in the hope of securing an early crop. Occasionally, such plantings do well, but usually the stand is poor, necessitating much replanting, and the early plants which do survive are likely to be so badly stunted by reason of the cool weather that they do not mature their crop much in advance of the later plantings which have had the benefit of warm weather from the start.

Preparations for Planting.—Melon ground should be plowed early in the spring, or replowed if it was broken in the fall. After plowing, it should be thoroughly pulverized by the use of a disk or harrow, or both, and then kept in good, friable condition by occasional working until planting time arrives. Shortly before planting is to begin, the field should be furrowed out both ways with a single-shovel plow or a one-horse turning plow. The furrows should be about six inches deep, and as far apart as the hills are to be placed. On some soils melon vines make only a moderate growth and the hills may be planted as close as four feet apart each way; but on rich soil, where they make a stronger growth, they should be at least five by five, and in some cases six by six. After the land is furrowed out the rotted manure is applied at the intersections of the furrows. From a quart to a half-peck of manure is used for each hill, depending upon the quality of the manure and also the quantity available. The manure is dropped into the bottom of the furrow, and either mixed thoroughly with the soil there, and covered with a layer of pure soil in which to plant the seed, or is merely covered with the soil without any mixing. The latter method seems to give fully as good results as the former, especially when a small quantity of manure is used, and is a great saving of labor. In either case, especial care should be taken to compact the soil over the manure so that when the seed is planted it will not suffer from lack of moisture by reason of any vacant air space in or about the mass of manure. Sometimes the manure is covered with soil by merely plowing a furrow on each side of the furrow containing the manure, but unless the soil is in exceedingly fine condition, this method is not as satisfactory as using a hoe and giving each hill individual attention. In making the hill, some

planters compact the soil with the hoe, while others use the feet. When ready for planting, the hill should be practically level with the general surface of the field. If too low, the hill will become water-soaked in case of rain and the seeds or plants injured; if too high, there is likely to be insufficient moisture to insure proper germination and growth.

Planting the Seed.—If the hills have been made more than a few minutes before the seed is dropped, the top layer of dry soil should be scraped aside with a hoe so that the seed may be placed in immediate contact with moist soil. The area thus prepared for planting the seed should be at least six inches across, and should be smooth and level. From ten to fifteen seeds should be scattered uniformly over this area, and covered with about half an inch of fine, moist soil. This should be firmed with the back of the hoe and then covered with a sprinkle of loose dirt to serve as a mulch. If a heavy rain packs the top of soil and a crust is formed before the plant appears, it is wise to go over the field and carefully break the crust over each hill by means of a garden rake. The method of preparing the hills and planting the seed described above applies to field rather than garden conditions and to soils of medium rather than excessive fertility. In a market garden where the soil is exceedingly rich as a result of repeated manuring for onions or cabbage, and is in fine tilth, it is a common practice to sow the melon seed in drills six to eight feet apart, by means of a garden seed drill. This is done without any special preparation of the soil where the plants are to stand, or application of fertilizing material other than manure applied broadcast before plowing.

Thinning.—While ten to fifteen seeds are planted per hill for the sake of insuring a full stand, only two, or at most three, plants are left to make the crop. Thinning is usually deferred until the plants have become fully established, and the struggle against the striped beetle is nearly over. However, the plants must be thinned before they begin to crowd badly, or those which are to remain will be stunted in growth. Usually the thinning is completed by the time the plants have four rough leaves. If the seed has been well scattered in planting, so that each plant stands apart by itself, the superfluous plants may be pulled with the fingers, but extreme care must be taken to avoid disturbing the roots of the remaining plants. Sometimes the plants are cut off with a knife or shears, instead of being pulled, and thus all danger of disturbing the roots is avoided. If the seeds have been sown with a drill as in market gardening practice, the plants are usually thinned to one in a place at distances of two to two and one-half feet in the row.

Transplanting.—Since it is impossible to increase the earliness of the crop to any great extent by early planting in the field, growers have adopted the transplanting method. This makes it possible to plant the seed three or four weeks earlier than would otherwise be feasible, and to grow the plants under controlled conditions of temperature and moisture during their most critical period. It also simplifies the matter of protection from striped bettles. The main ob-

jections to this method are the expense for sash, and the difficulties attending the transplanting. A melon plant will not survive transplanting if the root system is disturbed. For this reason the seed is sown on inverted sod, in pots or in dirt bands. The dirt bands are used almost exclusively by commercial growers. These are thin strips of wood veneer, three inches wide and eighteen inches long, scored at intervals of four inches so that they can be bent without breaking. When folded ready for use, each band resembles a small strawberry box without the bottom. These bands are placed close together in a hotbed and filled level full with fine, rich soil. With a block of wood shaped for the purpose, the soil within the bands is pressed until it is ½ to ¾ inch below the top of the band. If only part of the dirt is put in at first, and is pressed down firmly, then the rest of the dirt put on and pressed, the soil in the band will be more compact throughout and will hold together better in the transplanting than if the dirt were pressed only once. Unless the soil used was very moist, the bed is then thoroughly watered. Next, three seeds are placed in each band. These are covered with fine, loose soil deep enough to fill the band. This soil is not firmed. The hotbed for melon plants should have full exposure to light and be maintained at a high temperature—about 85 degrees F. during the day and 65 to 70 degrees at night. As much ventilation should be given as the weather will permit, and care exercised to avoid over-watering. As soon as the plants are well started, they are thinned to two in a band by cutting off the extra plant with a sharp knife. When the plants are about four weeks old from the planting of seed they will be in the right condition for transplanting to the field. They are then compact, stocky plants with about four rough leaves. If allowed to remain longer in the bed they begin to stretch for light and are of little value for planting, for the long naked stems, unable to support themselves and unaccustomed to direct sunlight, would easily be sunburned, and the plants seriously checked if not killed outright.

Cultivation.—Whether the melons are transplanted from a hotbed or grown from seed planted in the field, the tillage of the crop should begin as soon as the plants can be seen. In the case of transplanted plants, this will be the same day that they are set in the field. The early tillage should be deep, and as close to the plant as it is feasible to run the cultivator. The object of this deep tillage is to establish a deep root system so that the plants will not suffer so severely from dry weather later in the season. In the case of a field planted crop it is not feasible to cultivate so close to the plants early in the season because of the danger of tearing out the little plants. For this deep tillage a one-horse five-shovel cultivator, often weighted with a rock, is the tool most commonly used. It is customary to follow this with a "boat" or a 14-tooth cultivator to more fully pulverize the soil. Tillage is usually given after each rain or at least once each week so that the soil is maintained in a loose friable condition. In addition to the cultivation with a horse, much hand hoeing is required close about the plants. Any crust forming after a rain, is broken, and fresh, moist soil drawn up about the plant. Crab grass

and weeds appearing in the hill are removed by hand. Most growers cease tillage and lay-by the crop as soon as the vines have run enough to interfere with the cultivator. The experience of a few growers who have turned the vines and kept them in windows so that tillage could be continued until the picking season opened, indicates that a departure from the old method is likely to insure better development of the melons and a longer picking season, though the first fruits may not ripen so early. There is another distinct advantage in this turning of the vines, in that the gathering of the crop is greatly facilitated and there is no injury to the vines from tramping.

Seed.—No matter what variety of melon is grown, it is extremely important that pure seed be planted if good melons are to be produced. The melon deteriorates very rapidly under careless methods of seed selection. None but the very choicest specimens of the desired type, from productive vines, should be selected for seed. It is unsafe to cut seed from a field in which more than one variety of melon is grown; for seed from such a field would likely be very badly mixed, and the product undesirable for market. If a grower has sale for all his good melons, it may be cheaper for him to purchase his seed than to save it. But here again there is danger of procuring inferior seed, for much of the melon seed on the market is cut without careful selection, in order to meet the demand for cheap seed. Even cull melons are used to supply this demand. Such seed is expensive at any price. The difference in the cost of good seed and poor seed is insignificant when compared with the advantages to be derived from the use of seed which can be depended upon to produce melons of a given type.

Picking.—There is considerable difference of opinion as to the exact stage of maturity at which melons should be picked for shipment. If allowed to become too ripe before picking, they become soft by the time they reach the market, and often must be sacrificed in order to effect an immediate sale. If picked too green, the melons reach market in firm condition, but are lacking in flavor, and are not desired by the best trade. It is a nice point to pick melons at such a degree of ripeness that they will reach the market in firm condition, and yet possess the requisite flavor. The farther from market the melons are produced, the less mature they must be when picked. Furthermore, the rapidity of softening after picking varies with the temperature to which the melons are subjected. The cooler they can be kept after picking, the longer they can be allowed to remain on the vines and the better flavor they will have. It is, therefore, essential that the melons be placed in the shade as soon as possible after picking, and be kept shaded until they are loaded into the car. For the same reason, riper melons can be shipped under the refrigeration than in ventilated cars. It is also true that melons shipped during excessively hot weather, unless under refrigeration, will soften more rapidly than those shipped during cooler weather. The condition of the vines and the rapidity of ripening of the melons in the field will also have a bearing upon the stage of maturity at which they should be picked. Early in the shipping season, when the vines are in full

vigor and the melons ripening slowly, the fruits may safely be left upon the vines until more mature than would be safe later in the season when the plants have become somewhat weakened, or, by reason of excessive heat, the melons are ripening very rapidly. Melons should not be picked at the same degree of maturity under different conditions of ripening, methods of transportation, and distances from market.

While it is true that no rule can be given for picking melons that will apply under all conditions, and that the grower must exercise judgment in reference to each day's picking, the ideal will be attained when the conditions are such that the melons will reach the market in the best condition if picked as soon as the fruit will part readily from the stem when the latter is pressed with the thumb or finger. There is a tendency among some growers to pick considerably before this point has been reached, in order to run no risk of the melons becoming soft in transit. In fact, some growers make a practice of picking the melons before a crack appears about the stem or any change of color takes place, even on the under side of the fruit.

Market Demands.—While various types of muskmelon may be disposed of upon a local market, there are certain types which are recognized as standards in the large city markets; and it is seldom wise to attempt to force upon a general market a variety not recognized as a standard in that particular market. In the Chicago market the sorts most in demand are the Netted Gem, or Rocky Ford type, and the Osage.—(Ill. E. S. 124, 139; F. B. 255; S. Dak. E. S. 67; N. Hamp. E. S. 70, 96; N. Y. E. S. 200; N. Mex. E. S. 63.)

MELON—WATERMELON.

The cultivation of the watermelon is practically the same as for the muskmelon, except that the plants grow larger and require more room for development than those of the muskmelon. Watermelons require that the soil should contain a larger percentage of sand than muskmelons, and that the land should be quite rich. Watermelons should be planted 10 feet each way between the hills, or in drills 10 feet apart and thinned to 3 feet apart in the drills. The watermelon seedlings must be protected from the cucumber beetle until the foliage becomes toughtened. Watermelons readily group themselves into six classes based upon the color or characteristics of the skin or external appearance. It does not necessarily follow that in the proposed classification the fruit of each variety will all be of the same form to which it is referred; for, as every melon grower knows, the fruits in each hill vary more or less; but if everything is normal and favorable for their development the characteristic form or that typifying the variety will predominate. The larger the experience of the grower, the easier it is for him to understand these various types. In order to get the true type of each variety, it is important that the seeds be secured directly from the seedsman who first introduced them thus avoiding complications or errors.—(F. B. 255; N. H. E. S. 86; Ind. E. S. 123; N. Mex. E. S. 63; S. Dak. E. S. 67.)

Exhibit of Farm Products at Boys' School, Keokuk, Iowa.

Jerry Moore, of South Carolina, a Member of the Boys' Corn Club, and Part of His $228\frac{3}{4}$ Bushels of Corn Produced on One Acre in 1910.

I. Light Green Class	Sweet Heart Type (oval shape)
	———— ——— (medium shape)
	Monarch Type, (Long shape)
II. Medium Green Class	Icing Type, (oval shape)
	———— ——— (medium shape)
	Jackson Type, (long shape)
III. Dark Green Class	Black Spanish Type (oval shape)
	———— ——— (medium shape)
	Boss Type, (long shape)
IV. Light Striped Class	Kolb's Gem Type, (oval shape)
	Cuban Queen Type, (medium shape)
	Rattlesnake Type, (long shape)
V. Dull Striped Class	Pride of Georgia Type, (oval shape)
	Christmas Type, (medium shape)
	Favorite Type, (long shape)
VI. Mottled Green Class	Nabob Type, (oval shape)
	Phinney Type, (medium long shape)

MUSTARD.

Almost any good soil will produce a crop of mustard. The basal leaves of mustard are used for greens, and as the plants require but a short time to reach the proper stage for use frequent sowings should be made. Sow the seeds thickly in drills as early as possible in the spring, or for late use sow the seeds in September or October. The forms of white mustard, of which the leaves are often curled and frilled, are generally used. Mustard greens are cooked like spinach. —(F. B. 255; Mich. E. S. 20; La. E. S. 90.)

NASTURTIUM.

The hardiness and unsurpassed beauty of this plant should make it a favorite near every home. The seed pods just before begin-

ning to ripen make a delicious flavoring for pickles.—(Mich. E. S. 20; S. Dak. E. S. 68.)

NEW ZEALAND SPINACH.

The plant known as New Zealand spinach is not a true spinach, but grows much larger and should be planted in rows 3 feet apart, with the plants 12 to 18 inches apart in the row. Some difficulty may be experienced in getting the seeds to germinate, and they should be soaked one or two hours in hot water before planting. New Zealand spinach is satisfactory for growing in warm climates, as it withstands heat better than the ordinary spinach. The fleshy leaves and tender stems are cooked the same as spinach.

OKRA (*Gumbo*).

This plant may be grown throughout the greater portion of the United States, but only one crop can be produced during a season in the northern part of the country. In the region around New Orleans successive plantings are made and a constant supply is maintained. The plant is of a tropical nature and will not endure frost, but the pods begin to be produced very soon after the plants start into rapid growth and continue to form for several weeks, especially if all pods are removed while young and no seeds allowed to ripen upon the plants.

Soil and Its Preparation.—The soil upon which okra can be most successfully grown is a rich mellow loam, plowed rather deeply and well worked over with pulverizing tools. After the seedlings become established and the roots get a firm hold of the soil, the growth is very rapid and a large amount of available plant food, especially of a nitrogenous nature, is required. Quick-acting commercial fertilizers may be applied in moderate quantities, but these should be well mixed with the soil. The same conditions that will produce good cotton or corn will be found suitable for the production of okra.

Planting the Seed.—Throughout the Northern States planting should be done as early as possible in spring, or as soon as the soil is warm enough for the planting of general garden seeds. In the Southern States, where a continuous supply is desired, successive seedings of four or five weeks apart should be made. Plant in rows 3½ feet apart for the dwarf types, and 4½ feet for the larger-growing varieties. Scatter the seeds in drills, or plant loosely in hills, as with corn, and cover to a depth of 1 or 2 inches, according to the compactness and moisture content of the soil. The seeds may be planted with any good seed drill, but when placed in hills they should be separated 3 or 4 inches to allow space for the development of the stems. If the soil is reasonably warm, germination will take place within a few days, but should there be a heavy rainfall in the mean time the soil should be lightly cultivated between the rows and the crust broken over the seed by means of an iron rake.

Cultivation.—As soon as the plants are well established they may be thinned to three or four in a hill, or, if grown in drills, to 12 or 14 inches for the dwarf and 18 to 24 inches for the larger growing varieties. Where vacant places occur from failure in germination they may be filled in by transplanting. Cultivate as in the case of

corn or cotton, keeping the ground well stirred and the surface soil loose, especially while the plants are small. After the leaves begin to shade the ground, very little cultivation is necessary except to keep the land free from weeds. A poor soil and insufficient moisture will yield pods of inferior size and quality, and irrigation may often be desirable in order to produce a marketable crop. Okra is sometimes grown as a mixed crop with cotton, the okra being removed before the cotton begins to mature; but this practice is not to be recommended, as both crops draw heavily upon the nitrogenous matter of the soil. The okra plants will usually continue to grow until late in the season, but after a time the pods are not so large or tender as those produced earlier in the season. As the pod is the only part of the plant ordinarily used for food, it is desirable to secure a rapid and continuous growth in order to produce the greatest quantity of marketable pods.

Gathering and Marketing.—As soon as the plants begin to set fruit the pods should be gathered each day, preferably in the evening. The flower opens during the night or early morning and fades after a few hours. The pollen must be transferred during the early morning, and the pod thus formed will usually be ready for gathering during the latter part of the following day, although the time required to produce a marketable pod varies according to the age of the plant and the conditions under which it is grown. The pods should always be gathered, irrespective of size, while they are still soft and before the seeds are half grown.—(F. B. 232.)

Cultivation for Seed.—If okra is to be grown for seed alone, only one variety should be planted, or if more than one variety is grown each should be separated from the other by at least one-fourth mile to prevent mixing. When several varieties of okra are grown near each other no seed should be saved except that produced by the method of bagging and hand pollination. To secure seed in this way is a rather simple matter when only a small quantity is required, as the pods formed on a single day when the plants are at their best will produce enough seed. The bags should be tied over the flower buds in the evening and the pollen transferred early the following day. Replace the bags immediately, as an insect or the wind may at any moment bring to the flower the pollen of another variety. After going over all the flowers of a variety it is well to return to the first three or four and repollinate them in order that they may receive pollen from different individual flowers of the same variety and to insure perfect fertilization. Before beginning upon another variety the brush used for transferring the pollen should be thoroughly cleaned. If a brush is not available, use a portion of a young leaf, folded together between the thumb and finger, to convey the pollen. This improvised brush should be discarded and a new one adopted for each variety. The bags need remain only during the day on which the pollen is transferred and may be replaced by a tag to mark the pod. The seed should remain on the plant until fully ripe.

The common bumblebee is a frequent visitor to the flowers of the okra, and a single bee was on one morning observed to pollinate over

500 flowers, comprising more than 50 separate samples. In this instance practically every flower in the field was visited and pollinated, although no pollen had previously been transferred. This observation demonstrated the necessity of great care to prevent cross-pollination. Our variety tests with okra have shown that seed growers have not always succeeded in keeping the varieties separate, and as a result there has been a gradual blending together of all the sorts. In many of the samples all the sorts usually grown are represented.

Uses.—The principal use of okra is in soups and various culinary preparations in which meats form an important factor, as in the so-called gumbo soups, to which the young pods impart an excellent flavor, besides giving a pleasant mucilaginous consistency. The young seeds are occasionally cooked in the same way as green peas, and the very young and tender pods are boiled and served as a salad with French dressing. Both the stem and the mature pod contain a fibre which is employed in the manufacture of paper. No copper, brass, or iron cooking vessels should be employed in preparing okra, as the metal will be absorbed and the pods discolored or even rendered poisonous. The cooking should be done in agate, porcelain, or earthen ware.—(F. B. 232.)

Varieties.—There are three general types of okra, viz., tall green, dwarf green, and lady finger. Each of these is again divided according to the length and color of the pods, making in all six classes or varieties, namely, tall green, long pod; tall green, short pod; dwarf green, long pod; dwarf green, short pod; lady finger, white pod; and lady finger, green pod. All variations from these are merely the results of mixtures, no true crosses or hybrids being formed. These mixtures are easily separated and referred to the parent type, and a little attention to roguing and selection is necessary in order to keep the varieties pure. It is essential that the parietal strain should be pure in order that a uniform and marketable lot of pods may be produced.—(F. B. 232, 255; U. Id. E. S. 10.)

ONIONS.

The onion is exceptional in that it will thrive under a very wide range of climatic and soil conditions. There is perhaps no extended area in the United States, except the mountainous regions, where the onion can not be successfully grown. For best results a temperate climate without great extremes of heat and cold should be selected. Onion culture is rarely profitable in regions where the climate does not change or has no definite seasons of heat and cold or wet and dry. Naturally the onion does best under rather cool conditions, with plenty of moisture during its early stages, but requires a reasonable degree of heat, together with dryness of both soil and atmosphere, for its proper ripening.

Soils.—The essential requirements of a soil upon which to grow onions profitably are a high state of fertility, good mechanical condition in order that the crop may be easily worked, sufficient drainage, and freedom from weeds. If a soil has the proper mechanical properties—that is, if it contains sufficient sand and humus to be easily worked, is retentive of moisture and fertilizers, and is capable of

drainage—all other requirements can be met. As a general rule new land is not adapted to onion growing until it has been worked one or two years with other crops. Onions should follow some crop that has been kept under the hoe and free from weeds the previous season. Corn, beans, and potatoes are suitable crops with which to precede onions. Muck and sandy soils may in some cases be brought to a suitable condition for onions the first season, but the fitting will have to be very thoroughly performed. The land should be plowed in the autumn, then replowed in the spring, after which numerous harrowings and doubtless some hand work will be required to get the soil in suitable shape. If necessary to manure the land heavily before planting to onions, it will be desirable to plant to some farm crop one season, then apply the manure during the autumn in order to give it time to become incorporated with the soil. Owing to the value of good onion land it would not be advisable to devote it to general farm crops for any extended period, although corn is frequently planted and oats or rye are sometimes used in the North. Cowpeas may be of great service in bringing new land into shape for planting to onions.

Preparation of the Soil.—Assuming that the land intended for planting to onions is capable of being brought to a good mechanical condition, fertile, well drained, and reasonably free from weed seeds, the first step in the production of the crop will be to plow moderately deep, then harrow, disk, roll, and drag until the soil is smooth and mellow to a depth of 4 or 5 inches. On soils that are naturally well drained and where surface water can not accumulate, the plowing may be done in large blocks, but where the opposite conditions are found or irrigation is practiced it may be necessary to plow the land in narrow beds. In the case of insufficient drainage it will be desirable to throw the soil together into beds, leaving a double furrow between each bed to carry off surplus water. Where the flooding system of irrigation is practiced the beds must be leveled and a system of ditches and ridges provided for distributing and controlling the water.

Crop Rotation.—Onions should not be planted on the same piece of land year after year, and some system of crop rotation should be maintained. Care should be taken, however, to use crops in the rotation that will not be exhaustive of the high fertility necessary in the onion land. During the years when the land is not devoted to onions it can be planted to some truck crop that will give a return that will justify the application of large quantities of fertilizers, or, better to a leguminous crop to be turned under as green manure. Continuous cropping with onions will cause the land to become infested with both disease and insect enemies that will sooner or later injure the crop to such an extent as to render it unprofitable.

Fertilizers.—As the onion is an intensive crop and yields great quantities of marketable bulbs for the area planted, the grower is justified in manuring heavily. It would be difficult indeed to make the soil too rich for onions, provided the manures are thoroughly incorporated with the soil. A heavy application of fresh raw manure

just before planting would have an injurious effect, but where the manure is well rotted and uniformly applied there is nothing to be feared.

Animal Manures.—There is perhaps no fertilizer so well adapted to the production of onions as plenty of clean, well-composted stable manure, and the quantity and frequency of application will depend upon the nature of the land under cultivation. All stable manure used on onion land should be well composted before use and then spread upon the land several months before planting to onions. In the Northern States the manure may be applied during the autumn and well disked into the soil. The land can then be allowed to lie in the rough state and exposed to the action of frost during the winter, or it can be smoothed and seeded to rye, in which case it will be necessary to replow during the early springtime. Large quantities of fresh manure applied to onion land just before planting will have a tendency to produce an overgrowth of tops at the expense of the bulbs. This is especially true on irrigated lands and soils that are naturally moist.

Commercial Fertilizers.—Where there is an abundance of humus matter in the soil the onion crop will be greatly benefited by moderate applications of high-grade commercial fertilizers. Many growers follow the practice of applying only a part of the fertilizer at planting time, reserving the balance to be put on as a top-dressing at some time during the period of cultivation. This plan is especially desirable where onions are grown during the winter, as the application of highly nitrogenous fertilizers in the autumn is liable to promote a soft growth that will be injured by cold. If the fertilizer is not put on until cold weather is over, the crop may be forced without danger of injury. For this purpose only those fertilizers of a very available form will answer.

Planting and Thinning.—Experienced growers are frequently able by using extreme care in regulating the drills to distribute onion seed in rows where the crop is to mature so that little thinning will be necessary. Thinning is generally left until the time of the first hand weeding, when all thick bunches along the rows are thinned to a uniform stand of eight or ten plants to the foot. It is always well, however, to allow for considerable loss of plants, and unless the plants are so thick as to actually crowd, thinning will not be necessary.

Transplanting.—The transplanting process, often spoken of as the "new onion culture," is merely a modification of the regular seeding method. The objects gained by transplanting are an earlier crop, a uniform stand, and bulbs of more regular size. Where a small area is to be grown, the transplanting process is the ideal method, but for large acreages and where labor is difficult to obtain, this would not be practical. After transplanting, the seedlings will require rain or watering in order that they may start, and for this reason the transplanting process is practically limited to areas where some form of irrigation is available. In growing onions by the transplanting method the seed is sown in greenhouses, hotbeds, cold frames, or specially prepared beds at the rate of 3½ or 4 pounds for

each acre to be planted. When the seedlings are grown under cover, they are given the necessary attention regarding watering and ventilation and kept growing quite rapidly until near the time for setting them in the open ground. As planting time approaches, the seedlings are "hardened" or prepared for transplanting by increased ventilation and exposure and by withholding water. When ready to transplant, the seedlings should be somewhat smaller than a lead pencil and rather stocky. The plants are lifted from the seed bed and the roots and tops both trimmed somewhat.

Methods of Tillage.—The cultural requirements of the onion are frequent shallow stirring of the soil and freedom from weeds. The feeding roots of the onion run close to the surface of the soil and should not be disturbed by deep cultivation. Sometimes a heavy rain immediately after seeding will so pack the surface that the seedlings can not break through. Under such circumstances it will be necessary to slightly break the surface by means of a steel rake or a rake-like attachment on a cultivator. As soon as the plants are up and the rows can be followed the cultivator should be started to loosen the soil, which is always more or less compacted during seeding. It is well-nigh impossible to produce a crop of onions without some hand weeding. During favorable seasons the strictly hand work may be reduced to but one or two weedings, but a greater number will be necessary during rainy seasons. The work of hand weeding may be facilitated by the use of some of the small hand tools designed for the purpose. Among these tools might be mentioned the onion hoe, the hand weeder, and the thinning or weeding hook.

Irrigation.—Outside of the areas where irrigation methods are depended upon for the production of general crops it is not customary to use artificial watering in the growing of onions.

Harvesting.—In the North the bulbs are allowed to become as as ripe as possible before removing them from the soil. Growers prefer that the tops ripen down and shrivel and that the outer skin of the bulbs be dry before they are pulled. To the southward, where the onions are not cured so thoroughly, they are often pulled about the time that the tops begin to break and fall. The ripening process may often be hastened by rolling a very light roller or a barrel over the tops to break them down. This process is frequently spoken of as "barreling." Where the bulbs are practically upon the surface they may be pulled by hand and thrown in windrows consisting of eight or ten onion rows. If the onion bulbs are considerably covered with soil it will be necessary to employ a one-horse plow or a cultivator with a sweep attached for lifting them. In any case it will be necessary to gather them from the soil by hand. After lying in the windrows for several days and being stirred occasionally with wooden rakes they are gone over and the tops removed either by twisting or cutting with ordinary sheep shears. In cases where very bright color is important as with fancy White Globe onions, and this would be injured by exposure to the sun and rain, the bulbs are cured in long, narrow, low ricks formed by two rows of onions laid with the bulbs

regularly to the center, tops to the outside, the rows a few inches apart at the bottom of the rick but coming together at the top, and the top of the rick covered by straw or boards to shed the rain. As the tops are removed the bulbs are generally placed in crates for drying. In some sections onion-topping machines are employed, the bulbs being hauled from the field to a central location and run through the topper. These machines remove the tops, grade the bulbs, and deliver them into the crates or bags. If crates are not employed for curing, the bulbs are allowed to lie in the windrows for some time, and are then either put into sacks or hauled to slat cribs, where they complete the curing process. Too long exposure to hot sunshine will injure the bulbs. Where the bulbs are extremely dry at the time of their removal from the soil, they may be allowed to lie in the windrows for a few days only, and then sorted and cleaned in the field ready for packing and marketing.

Storage.—In order that onions should keep well when stored they must be well ripened and thoroughly cured. Those that are immature, soft, or "thick necks" should never be placed in storage but sold as soon as gathered for whatever price they will bring. Good storage onions will rattle almost like blocks of wood when poured from one crate to another. In order that the bulbs may remain bright and of attractive appearance they should not be allowed to lie exposed to the weather, but should be hauled and stored in open sheds just as soon as they may safely be placed in one-bushel crates. After the bulbs have remained in drying sheds or cribs for several weeks they will be ready for screening and removal to the storehouse. In handling onions it is the rule to pass them over a screen each time they are moved, as in this way the loose skins are removed and any soft or decaying bulbs may be sorted out. The essentials for the successful storage of onions are plenty of ventilation, storing in small quantities, a comparatively low temperature, dryness, and safety from actual freezing. Any building wherein the above conditions may be secured will answer.

Marketing.—Large quantities of onions are sold and shipped direct from the fields where they are grown. A part of the crop is held in temporary storage until late autumn or early winter. During recent years the winter storage of onions has become of great importance and the finest stock is held for late winter deliveries. The Bermuda crop from the southwestern part of the country comes upon the market during April and May, so that most of the storage onions are disposed of before that time. In marketing onions the first essential is to properly grade and clean the bulbs, in order that they may present an attractive appearance when offered for sale. Ordinarily the bulbs are separated into three grades—primes, seconds, and picklers. The primes include all those of 1¼ inches in diameter and larger, and the seconds consist of those from ¾ inch to 1¼ inches in diameter, while all those that will pass through a ¾-inch screen are sold for pickling purposes. The grading is generally done in the field during the cleaning process, but as onions

shrink considerably while in storage it is necessary to regrade before placing upon the market.

Weight of Onions.—The legal weight of onions per bushel varies somewhat in different States, but 56 pounds of dry onions are generally considered a standard bushel.

Important Commercial Varieties.—The varieties of onions that have distinctively yellow, white, and red skins and are of the globular type are of greatest commercial importance. Among the varieties that belong to the yellow globe class are the Prizetaker, Yellow Danvers, Yellow Globe, Danvers, Southport Yellow Globe, and Ohio Yellow Globe. The principal white varieties are Southport White Globe, New Queen, Italian Tripoli, Silver Skin, and White Silver King. Among the more important red sorts are Red Globe, Red Wethersfield, and Australian Brown. The principal Bermuda varieties are Red Bermuda, White Bermuda and Crystal Wax. The Bermuda onions are all of the more or less flat type. The red coloration of the Bermuda onion is not distinctive like that of the Red Wethersfield or Red Globe varieties, but is lighter in color. The famous Denia onion is somewhat of the Prizetaker type, is light yellow in color, grows to a large size, and is mild in flavor. In the selection of varieties for any particular locality the soil conditions and market requirements should both be considered. Those adapted to the muck soils are the yellow and red sorts. For alluvial and prairie soils the red and brown varieties are to be preferred, while all kinds do well on the sandy loams and light soils. A cleaner, better grade of white onions can generally be produced on light or sandy soils than on muck or clay loams. Those of the Bermuda, Spanish, and Egyptian types flourish on the deep, rich alluvial soils of the river bottoms and delta regions. Certain of our markets show a decided preference for onions belonging to a particular type. The red and brown varieties find ready sale on the markets of the Middle West, while onions of the yellow and white varieties are preferred in the eastern cities. Onions will withstand long-distance shipment, those of the Red Globe type being generally more subject to injury than the yellow and brown sorts. Some of the white varieties also have a thin skin and are easily injured. It should be the aim of every grower to employ varieties that will withstand handling and at the same time find ready sale on the market. Other types of onions are top onions, multipliers, garlic, and leeks, which are planted to some extent for marketing purposes.

Bermuda Onions.—The production of Bermuda onions in the United States is a comparatively new industry and has thus far been undertaken mainly in Texas and California. Soils of a silty or alluvial nature are suited to the production of Bermuda onions, and those containing considerable sand are most desirable. The Bermuda requires a very rich soil for the best results, and this can only be obtained by first selecting a good soil and then manuring heavily. The Bermuda onion as grown in this country is a winter crop; therefore, mild climatic conditions are required. While the plants would withstand considerable freezing, their growth is seriously checked by

cold weather, and the crop will not mature in time for the early market if grown to the northward. The cultural methods employed in the growing of Bermuda onions are essentially the same as those for ordinary onions. As the greater portion of the crop is grown in a region which has no regular rainfall, irrigation methods are employed almost universally. The greater part of the crop is grown by the transplanting process and a great amount of hand labor is required. Bermuda onions are harvested as early as possible, generally before the tops have become fully ripened. Phenomenal yields of 34,000 and 35,000 pounds of Bermuda onions are frequently made on an acre of land, but this is far above the general average, which is in the neighborhood of 10,000 or 12,000 pounds to the acre. Many fields, especially when planted for the first time, do not yield as much as 10,000 pounds to the acre. On land that has been heavily manured and planted to onions for several years the yield averages about 16,000 pounds. The best Bermuda-onion farms are valued at $300 to $500 an acre. In order to prove profitable, the growing of Bermuda onions should be conducted on a comparatively large scale. The necessary land and irrigation facilities will require the initial outlay of from $10,000 to $30,000, and the running expenses are quite heavy. Labor can be secured at a low price, but is correspondingly inefficient and often not to be had in sufficient quantities. Furthermore, the markets are now pretty well supplied with Bermuda onions, and persons who desire to engage in their production are advised to investigate every phase of the industry before embarking too heavily in it. The expansion of the Bermuda-onion industry is limited by the facts that a large supply of bulbs can be grown on a comparatively small area, that the distance to market is great, that the product is perishable, and that the markets will consume only a limited quantity at the prices at which the crop can be sold with profit.

Green Onions for Bunching.—Another phase of onion culture that is of considerable importance in certain localities is the production of young bunching onions for the early spring trade. In several sections along the South Atlantic coast the growing of this class of onions is quite an enterprise. Many persons who are engaged in other lines of work follow the practice of growing a small area of bunching onions as a side issue. The varieties known as multipliers and top onions are generally employed for this purpose; however, bunching onions are sometimes grown from ordinary sets, from inferior and damaged large onions, and from seed. The multipliers and top onions are the only kinds adapted for this work on a large scale. For growing bunching onions the bulbs or sets are planted during the autumn either in beds or in rows 12 or 14 inches apart with the bulbs quite close in the rows. The bulbs will start growing within a short time and make more or less growth during the winter. As soon as the weather becomes warm during the first months of spring the onions make a rapid growth and are ready for marketing about the time peach trees begin to bloom. In marketing this class of onions the young shoots are pulled, the roots trimmed,

and the outside peeled off, leaving the stem white and clean. The onions are then tied in small bunches by means of a soft white string, the tops trimmed slightly, and the bunches packed in crates or baskets for shipment or sale on the local market. This phase of the onion industry is limited to small plantings and is well suited to the needs of the general market garden. During the springtime and early summer large quantities of ordinary young onions are pulled when the bulb is about the size of a fifty-cent piece, the roots and tops are trimmed, and they are then bunched and sold for stewing purposes. So far as known, this class of onions is not shipped to any great extent, but is sold mainly on local markets.

Home Production of Onion Seed.—The bulbs, or "mother bulbs," as they are commonly called, for the production of onion seed should be grown in the same manner as those intended for marketing, except that more care should be taken throughout. Some seed growers prefer to use 6 pounds of seed to an acre for the production of seed bulbs instead of 4 pounds, as ordinarily used in growing for market, in order that the bulbs may crowd and not become too large. The planting, culture, and harvesting of the bulbs are practically the same as for first-class marketable stock. Onion-seed growing is a two-year process and two crops are constantly to be cared for. After growing the bulbs the first summer they must be stored over winter and replanted the following spring for the production of seed. Meantime the crop for the next year's planting must be coming on in order to have a crop of seed every year. The first requisite for the growing of the best seed is a clear-cut ideal of the exact shape, form, color, and general characteristics sought in the variety being grown. The second requisite is the growing of seed from bulbs of that exact type for the greatest possible number of generations. Two selections should be made, the first to include but a small number of the very finest and most ideal bulbs from which to produce the stock seed to be used the following year for the growing of the seed bulbs, and the second to include the bulbs from which to grow the supply of seed for the market. By keeping the very best stock separate and using the product for propagation the entire strain will be gradually improved. Bulbs a trifle below the ideal market size, or about 1½ to 2 inches in diameter, are the most profitable for seed production.

Bulbs that are to be used for seed productions should be allowed to become thoroughly ripe in the field. After pulling they should be stored in crates under a roof where they will have plenty of ventilation and be protected from sun and rain. Before freezing weather begins the onions should be graded and removed to a house where both ventilation and temperature can be controlled. The temperature of the storage house should at no time be so low as to cause the bulbs to become frosted. A temperature of 32° F. for a short period will do no harm, but should not be allowed to continue. If the bulbs become frosted, heated, or sweated in storage they will sprout before planting time and be greatly injured for seed purposes.

In general, the storage conditions should be the same as for marketable onions.

The proper time to gather the seed is when the inside of the grain has reached the dough stage. Onion seed assumes its black color very early; in fact, before it has passed the watery stage and formed milk in the grain. This change of color is no indication of ripeness and very often deceives the inexperienced grower. The heads should be harvested just before the first-formed seed begins to shatter in handling.

Curing the Seed Heads.—Any building having a tight floor and in which a free circulation of air can be maintained will serve as a curing place for onion seed. In localities where rains do not occur during the curing period the seed heads are frequently dried on sheets of canvas stretched over frames or spread upon the ground. For curing the seed in houses, wire-bottomed racks or trays placed one above the other are generally employed. As the seed is stirred from time to time during the curing process considerable of it will be shattered and fall upon the tray below or finally upon the floor. The main essentials in the curing of onion seed are to spread the heads very thinly, not over two heads in depth, and to give free ventilation. Even at a depth of 3 inches in the trays it will be necessary to stir them very often, especially during damp weather.

Thrashing and Cleaning the Seed.—The date for gathering the seed depends upon the locality and climate, but as a rule this will be about midsummer. The thrashing and cleaning of the seed are often deferred until quite late in the autumn, except where the curing is done in the open air. Where large quantities of seed are produced the thrashing is done with machines similar to regular grain thrashers, but when grown on a small scale the seed is removed by beating with a flail.

After the seed has been thrashed, there is still considerable danger of its heating or molding if left in too great bulk. The usual practice is to run it through a fanning mill to remove the dust and small particles of the heads or chaff that are broken up in thrashing. In former years the method of cleaning was to place the seed in a tank of water the heavy seed settling to the bottom of the tank while the chaff and lighter portions could be floated off. This process is no longer used to any great extent, owing to the improvement in cleaning machinery, and the danger of injuring the seed by the water. After the seed is fanned and most of the foreign matter removed, it should be spread thinly on the floor or canvas and stirred from time to time. About the only test that can be applied in order to detect moisture in the seed is that of feeling it with the hand, and anyone experienced in the handling of seed will soon become expert at determining when it is safe to bag it ready for storage or shipment.

Production of Seed for Onion-Set Growing.—Frequently the seed for onion-set growing is produced from bulbs selected from the sets themselves; in other words, the bulbs or mother bulbs are the overgrown sets. Owing to the great quantity of seed employed in

set growing it is desirable to secure it cheaply, and the bulbs selected from the sets, being small, will produce a larger quantity of seed per bushel from mother bulbs than when grown in the usual manner. The stock seed bulbs should, however, be well matured, small necked, uniform in size, and selected according to an ideal shape. Onion seed from undersized bulbs is not so desirable, even for set growing, as that from standard bulbs. The length of time that onion seed will retain its vitality depends largely upon maturity and climatic conditions. Well-matured seed will always keep better than poorly ripened and inferior seed. Under ordinary conditions onion seed loses its vitality very rapidly after the second year, especially if stored in a damp climate. It will often pay to ship the seed to a dry climate for storage.

Production of Onion Sets.—The term "set," as applied to the onion, indicates a small, undersized bulb which, when replanted in the ground, will produce a large onion. This method of producing onions is perhaps the oldest and now the most universally employed for the growing of small areas of onions in the garden where an early crop is desired. The common method of producing sets is to plant a large quantity of seed on a small area of rather rich land and thus procure a great number of bulbs that are undersized, owing to crowding and lack of plant food. The greater number of these bulbs do not attain sufficient size or maturity to produce seed the following season and are really plants in which the process of growth has been arrested. The climatic conditions governing the production of onion sets are practically the same as those for standard onions, although it is not necessary to plant quite so early in the spring. As the essential feature of growing onion sets is the crowding together of the plants in the rows, a large quantity of seed is required to plant an acre. The quantity of seed required varies with the different localities. The ideal onion set is almost globular in shape and a trifle less than half an inch in diameter. The color should be bright and the surface free from smut or spots. The term "pickler" is applied to the onion just above sets in size, or, in other words, one-half to three-fourths of an inch in diameter. The term "boiler," or "stewer," is applied to the size next larger than picklers, which are too small for sale as standard onions, or from three-fourths of an inch to 1¼ inches in diameter.

Varieties Used for Sets.—Seed of almost any variety of onion may be used for the production of sets, but a greater demand exists for the distinctly yellow, white, and red colors. In the trade the sets are recognized by their color rather than by actual varietal names. The demand for the yellow and the white sets is greater than for the red, and those of the globular type are generally preferred.

Onion sets are sometimes grown from left-over seed, in which case a large number of varieties may be included. In the principal set-growing districts, where the seed has been locally grown for many years, the varieties are more or less distinct from those of seedsmen's catalogues.—(F. B. 255, 354, 434; Ariz. E. S. Cir. 75; Colo. E. S. 81, Cir. 5; N. Mex. E. S. 52, 74; Oreg. E. S. 74; N. Y. E. S. 206;

U. Id. E. S. 22; N. Dak. E. S. 12; S. Dak. 47; Mich. E. S. 6; Kans. E. S. 70.)

PARSLEY.

After soaking the seeds of parsley for a few hours in warm water, they may be sown in the same manner as celery seed and the plants transplanted to the open ground. At the North, parsley will live over winter in a cold frame or pit, and in the South it will thrive in the open ground during the winter, but it can not withstand the heat of summer. The plants should be set in rows 12 inches apart and every 4 inches in the row. The leaves of parsley are used for garnishings around meats and for flavoring soups.—(F. B. 255, 295; N. Car. E. S. 132; U. Id. E. S. 10.)

PARSNIP.

Sow the seeds of parsnip as early as convenient in the spring in drills 18 inches to 3 feet apart. Thin the plants to stand 3 inches apart in the rows. The parsnip requires a rich soil and frequent cultivation. The roots can be dug late in the fall and stored in cellars or pits, or allowed to remain where grown and dug as required for use. It is considered best to allow the roots to become frozen in the ground, as the freezing improves their flavor. As soon as the roots begin to grow the following spring they will no longer be fit for use. All roots not used during the winter should be dug and removed from the garden, as they will produce seed the second season and become of a weedy nature. When the parsnip has been allowed to run wild the root is considered to be poisonous.—(F. B. 255, 295; Mich. E. S. 20; U. Id. E. S. 10; N. Car. E. S. 132.)

PEAS.

Garden peas require a rather rich and friable soil with good drainage in order that the first plantings may be made early in the spring. Fertilizers that are high in nitrogenous matter should not be applied to the land immediately before planting, as they will have a tendency to produce too great growth of vines at the expense of pods. Land that has been well manured the previous year will be found satisfactory without additional fertilizer. A sandy loam is to be preferred for growing peas, but a good crop may be produced on clay soils; however, the pods will be a few days later in forming. Peas are easily grown and form one of the most palatable of garden products. For the best results peas should be planted in the bottom of a furrow 6 inches in depth and the seeds covered with not more than 2 or 3 inches of soil. If the soil is heavy the covering should be less than 2 inches. After the plants attain a height of 4 or 5 inches the soil should be worked in around them until the trench is filled. The rows for peas should be 3 feet apart for the dwarf sorts and 4 feet apart for the tall kinds. A pint of seed will plant about 100 feet of single row. Many growers follow the practice of planting in a double row with a 6-inch space between. The double-row method is especially adapted for the varieties that require some form of support, as a trellis can be placed between the two rows. Brush stuck in the ground will answer for a support for the peas to climb upon. Three-foot poultry netting makes a desirable trellis. If peas are

planted for autumn use, the earliest varieties should be employed. The first plantings should be of such varieties as Alaska or Gradus, which make a small but quick growth, and may or may not be provided with supports. The dwarf sorts like American Wonder come on later, require very little care, and produce peas of fine quality. The tall-growing sorts of the Telephone type are desirable for still later use on account of their large production and excellent quality. Sugar peas have tender pods and if gathered very young the pods may be eaten in the same manner as snap beans. In order to maintain a continuous supply of fresh peas, plantings should be made every ten days or two weeks during the spring months, beginning as soon as the ground can be worked. In the extreme South peas may be grown during the entire winter.—(F. B. 255; N. C. E. S. 132; Mich. E. S. 20, 190; S. Dak. E. S. 85, 91; Del. E. S. 41; Colo. E. S. 172.)

PEPPERS.

Plant the seed of peppers in a hotbed, and transplant to the open ground as soon as it is warm, or sow the seeds in the garden after all danger of frost is past. When grown in the garden the plants should be in rows 3 feet apart and 15 to 18 inches apart in the row. The plants require about the same treatment as the tomato. Peppers are divided into two classes—the sweet varieties, which are eaten as vegetables, and the pickling varieties, which are used for pickles or dried and powdered, in which form they are much used in Mexico. Of the sweet peppers the varieties Sweet Mountain, Ruby King, and Large Bell are good standard varieties; and of the pickling peppers, the Cayennes and Chilies are largely used. The pickling varieties are all more or less pungent and should never be prepared with bare hands, because the burning sensation is very difficult to eliminate.—(F. B. 255; B. P. I. 6; P. Rico 7; Iowa E. S. 47; N. C. E. S. 132.)

PHYSALIS.

The physalis is also known as the ground-cherry or husk-tomato. Sow the seed in a hotbed or cold frame and transplant to the garden after danger of frost is past, or the seeds may be sown in the row where the plants are to remain and thinned to 12 or 18 inches. No particular care is required except to keep them free from weeds. There are a large number of varieties of the physalis, and the fruits vary in size and color. The variety commonly used in gardens produces a bright-yellow fruit, which is about the size of an ordinary cherry. Toward fall the fruits will drop to the ground and will be protected for some time by their husks. If gathered and placed in a cool place the fruits will keep for a long time. The physalis will self-sow and may become a weed, but it is easily controlled. A few of the volunteer plants may be lifted in the spring and placed in rows instead of making a special sowing of seed. Ten plants will produce all the husk-tomatoes desired by the average family. The fruits are excellent for making preserves and marmalade.—(F. B. 255; S. Dak. E. S. 68.)

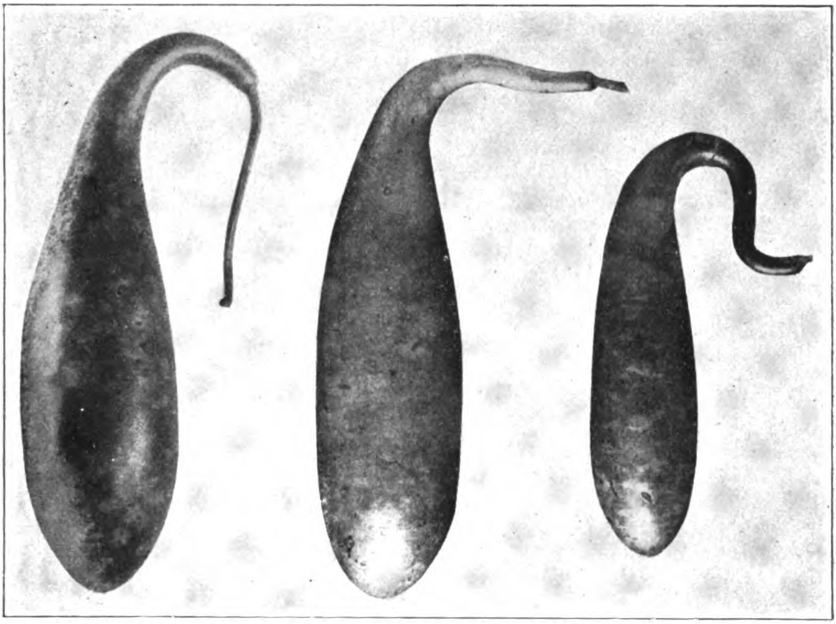
POTATO.

The term "potato," when not modified by an adjective, suggests to the mind of an American the so-called potato (*Solanum tuberosum*). When the name is modified by the word "sweet," reference is made to a different plant, belonging to the morning-glory family and known botanically as *Ipomoea batatas.* Attention is here directed entirely to the Irish potato.

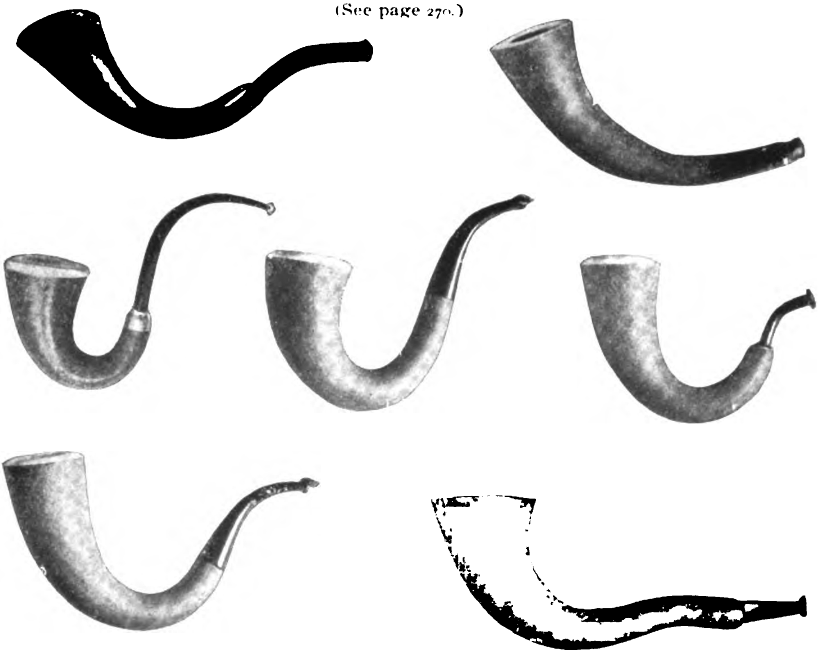
Soil and Rotation.—The potato is grown in every State and Territory, and naturally on a great variety of soils. Indeed, it has been grown on nearly every class of soils, but this fact does not minimize the importance of selecting for the potato the kind of soil best adapted to it. The ideal soil for this crop should be one so light as to offer no great resistance to the enlargement of the tubers, so supplied with organic matter as to be rather moist without being wet, and so rich as to furnish an unfailing supply of fertilizing ingredients. A rich, sandy loam abundantly supplied with organic matter and naturally well drained is preferable. Stiffer soils may be rendered suitable for the potato by drainage and by the incorporation of farm manures; or better, by plowing under green crops. Very heavy clay should be avoided if the farm contains any lighter soil. Recently cleared ground suits the potato. Sandy soils, if not too subject to drought, may be fitted for this plant by the addition of organic matter. It is claimed that potatoes grown on sandy land are of better quality than those grown on stiffer soil.

The potato requires a rich soil, but even more important than natural fertility is a proper mechanical condition of the soil. Artificial fertilizers may be substituted in part for natural fertility, but they are effective only when the soil is in such a condition as to furnish a constant supply of water. The potato should have the best soil on the farm, since it is more exacting in this respect than the other staple crops and since the product of an acre is generally of greater value. The success of the potato is largely dependent on the crops preceding it in the rotation. If clover, cowpeas, or other leguminous plant is grown just preceding potatoes, its stubble furnishes organic matter and adds to the store of available nitrogen in the soil. Corn after sod frequently precedes potatoes, and this is generally regarded as the best rotation.

Rye is sometimes sown in late summer or fall and plowed under so as to lighten a heavy soil. Buckwheat and other plants have also been used for the same purpose. On light soils and in rather mild climates, crimson clover for green manuring may advantageously take the place of rye where early planting of potatoes is not specially desirable. One year, or at most two years, is as long as a field should be devoted to continuous potato culture, although this crop is sometimes grown for more than two years in succession on the same land. This latter course taxes heavily the fertility of the soil and necessitates liberal manuring; moreover it involves considerable risk of injury from fungous diseases, especially from potato scab. A clean crop of potatoes can not, as a rule, be grown on land which in the preceding year produced scabby tubers. The germs of the disease



CALABASH PIPE GOURDS.
NOTE DIFFERENCE IN CURVES. ONE SIXTH NATURAL SIZE.
(See page 270.)



VARIOUS FORMS OF CALABASH PIPES.

once in the soil must be starved out by growing on the infected field other crops, such as grass or grain, for several years. In certain localities in the central part of the United States and elsewhere the following three years' rotation has given highly satisfactory results on farms where potatoes are extensively grown; Fall wheat, in which clover is seeded in the spring; second year, clover, plowed under in fall or winter; and third year, potatoes. In some localities the uncertainty in obtaining a catch of clover renders this rotation inexpedient.

Detailed directions for the preparation of one class of soils would not apply to others, hence it can only be said that preparation should be deep and thorough, and that unnecessary compacting of the soil should be avoided. Plowing can scarcely be too deep, provided that much of the subsoil is not brought to the surface; when practicable, the depth should be gradually increased from year to year. Though the tubers are usually formed within 6 inches of the surface of the ground, the roots feed deeper. Practical experience, as well as the extent of the distribution of potato roots in the soil, emphasize the importance of deep and thorough preparation of the soil for this crop. Whether fall plowing is advisable depends on a variety of local considerations. In general in a mild climate fall plowing of light land exposes it to leaching; on the other hand, fall plowing is sometimes necessary, as, for example, when a field is badly infested with injurious insects.

Fertilizing.—The potato requires liberal manuring. Barnyard manure usually affords a large increase in the crop, for not only does it supply nitrogen, phosphoric acid, and potash, but it improves the mechanical conditions of the soil. However, its direct application to the potato affords conditions favorable to potato diseases, and thus injures the quality of the crop. For this reason the best practice is to apply barnyard manure to corn or grass the year before the potatoes are grown. If it is considered necessary to apply it directly to the potato crop it should first be well rotted.

If for several years before potatoes are planted the land has been properly manured with farm manures, or with green crops plowed under, commercial fertilizers can be advantageously used on most soils. Generally, a complete fertilizer should be used—i. e., one which contains nitrogen, phosphoric acid, and potash. The farmer is justified in supplying all three of these fertilizing ingredients, unless by previous tests he has learned that on his soil a certain one of them can be safely omitted. Of nitrogenous fertilizers, one of the best for potatoes is the quick-acting nitrate of soda. Of phosphatic fertilizers, superphosphate is preferred. Among potash fertilizers the sulphate of potash has been found to afford a better quality of potato than kainit and muriate of potash. Ashes, are extensively and effectively used to supply potash to potatoes.

As little farmyard manure is available in the Southern States where the early crop of potatoes is chiefly produced, this seldom enters as a factor in the production of the crop. Commercial fertilizers of a nature especially adapted to the potato crop form the chief re-

liance of the growers. A fertilizer carrying 3 to 4 per cent of nitrogen, 6 to 8 per cent of phosphoric acid, and 8 to 10 per cent of potash is used at the rate of 500 to 1,500 pounds to the acre, depending upon the crop which is to follow the potato crop and the liberality of the grower. The fertilizer may be applied broadcast if put on at the rate of 1,000 pounds or more to the acre. When less than 1,000 pounds to the acre are used it is almost universally applied along the line of the row, a furrow being opened for the reception of the fertilizer; which is scattered by hand or by a distributor which can be used to fertilize several rows at a time. After the fertilizer has been distributed, a cultivator is run along the line of the rows to incorporate the fertilizer with the soil in order to prevent its coming in contact with the seed when planted. Sometimes the furrow is refilled and reopened prior to the planting of the seed, so as to incorporate the fertilizer more completely with the soil. Still another plan is to open the furrow, distribute about one-half the quantity of fertilizer to be used in the bottom, incorporate it with the soil, plant the potatoes, partially cover them, and scatter the remainder of the application on the seed bed above the seed.

Planting.—The rows should be laid off as close together as practicable without interfering with horse cultivation. Generally the seed pieces should be dropped in furrows made in the level field and not on ridges. However, low ridges are advantageous for an early crop and on poorly drained land. In covering the seed pieces, whether they are planted flat or on ridges, it is well to leave a small, sharp ridge marking the line of the row. In some localities, however, where excessive moisture is not feared, the opening furrows are only partially filled after planting, leaving a depression along the row to be filled by the use of the smoothing harrow or other implement. In planting late in the season this course is sometimes advisable. The pieces may be dropped by hand in the open furrow, or a potato planter may be used, dropping and covering the seed pieces at one operation. There are several potato planters that do very satisfactory work, but their cost restricts their use to those who plant a large acreage in potatoes or to cases where several farmers can use one together. Their more extended use is perhaps desirable, since they save a considerable amount of labor and enable the potato grower to take full advantage of even a brief period of favorable weather at planting time regardless of scarcity of labor. In the preparation of the ground and in planting, the earth along the line of the row should be compacted as little as possible consistent with thorough work, and hence the team should be made to walk between the rows whenever possible instead of along the drill. There is a simple potato coverer constructed somewhat like a triangular snowplow, with the wide end forward and a portion of the point or apex cut away so as to leave a narrow opening at the rear. No special implement, however, is required for this purpose.

Planting Machines.—Planting potatoes by hand on any large scale is out of the question on account of the expense. The large potato grower can of course afford the most modern machinery. In

a community of small potato growers it is possible for them to own machinery jointly, and thus avoid any large expense to the individual farmer. The two most expensive machines connected with potato growing are the planter and the digger. A word of caution about the type of planter is perhaps desirable. There are some planters which pick up the seed potatoes by means of a prong or fork which breaks the skin of the tuber. This exposes the potato to any germs of potato diseases which may be present in the soil. Furthermore, it carries any germ disease that may be on some of the seed potatoes to others. There are planters which pick up the potatoes in such a way as not to break the skin. This point is especially important in planting whole seed. In planting cut seed there is still the danger of transferring the disease from one piece of potato to another. Whatever planter may be used, some one should ride on the machine in order to see that it works regularly, so as to give as nearly a perfect stand as possible. The improved planters of today open the furrow, drop the seed, cover it, firm the dirt over the seed, and mark the next furrow. Such a planter is drawn by two horses. Experiments with potatoes planted in rows all the way from 36 to 42 inches apart indicate that the best distance depends upon the seasonal conditions and type of soil; it is a problem for each grower to solve for himself. The distance apart the potatoes should be planted in the row also depends so much upon the variety, the fertility of the soil, the availability of water, etc., that each farmer must determine this from his own experience.

Time of Planting.—Each community is the best judge of the proper date for planting. Where potatoes are grown for the early market the aim is to plant as early as possible, without subjecting the young plants to severe cold. The crop should be planted at such a date as to bring the stage of growth during which the tubers are rapidly developing at a time when there is ordinarily an adequate supply of moisture. The month when dry weather is most certain varies with the locality, and each potato grower should so time his planting as to be least affected by drought. Where the growing season is long the crop that is to be stored over winter should be planted very late, so that it may remain in the ground until cool weather. On the other hand, where the season is short, late varieties should be planted in time to ripen before frost.

Depth of Planting.—The roots of a young potato plant grow, not directly from the seed piece, but from the underground joints or nodes of the stem. From these underground nodes also grow the short stems which bear the tubers at their extremities. Hence the seed pieces should be placed deep enough in the soil to permit several of these joints to form below the surface, so as to afford room for an ample supply of roots and tuber-bearing stems to grow. Many experiments have been made to ascertain the best depth for planting. The results, with some exceptions, favor planting not less than 4 inches deep. The favorable effects of deep planting were especially marked on well-prepared, friable soil and in dry seasons. Very deep planting is open to objection because of the increased labor of harvesting and

the danger of a deficient stand when weather conditions are unfavorable. Very shallow planting reduces the yield and injures the quality of the crop.

Growing Seed Potatoes Under Mulch.—The Nebraska Experiment Station reported an interesting comparison of the value for seed purposes of potatoes grown under mulch with those grown with ordinary cultivation under like conditions, which indicates that the mulch method offers a convenient and practical means of producing good home-grown seeds under Nebraska conditions. The theory of the method and the results obtained in the comparative tests are thus stated: Potatoes are a cool-weather crop. It is because of this that they succeed so well in the far north. Moreover, potatoes require for their best development fairly uniform conditions, especially as regards soil moisture and soil temperature. This being the case, why should not potatoes grown under a litter mulch be especially well developed and therefore make strong seed? The soil beneath a mulch not only has a moderately low temperature during summer, but its temperature is also exceptionally uniform, varying not more than a degree or two between day and night and only a few degrees from day to day. The soil moisture beneath a good mulch is also more abundant and much more nearly uniform in amount than in case of bare ground, even though the latter is given good tillage.

The value for seed purposes of tubers grown under a litter mulch has been tested during two seasons at the experiment station. In 1904 a plat of potatoes was mulched with straw and an adjoining plat was given careful cultivation. The soil of the two plats was practically unform and the seed planted on the two plats was taken from the same lot of tubers. Seed was saved from the mulched and cultivated plats separately, kept under the same conditions during winter, planted on adjoining plats in the spring of 1905, and given identical cultivation during the summer. In 1906 the experiment was repeated with seed grown in mulched and in cultivated ground the year before. The same precautions were observed as in the first test. Uniform seed was used to start with in 1905. The seed saved from the mulched and from the cutlivated plats was taken as it came, without selection, and was kept over winter under the same conditions. Both kinds of seed were cut in the same way, planted in the same way, on adjoining plats, and treated alike as regards tillage, spraying, etc. Under these conditions any constant differences in yield between the two plats must be ascribed to the effect of the methods of culture employed the previous season. The yields obtained from the mulched and from the cultivated seed were as follows: Cultivated seed, 384 pounds in 1905; mulched seed, 563 pounds in 1905; cultivated seed, 123 pounds in 1906; mulched seed, 174 pounds in 1906.

The use of seed that had been grown under a mulch the preceding year increased the yield of potatoes 47 per cent in 1905 and 41 per cent in 1906. If further tests confirm the results reported here, it would seem that mulching might be used for the production of high-grade seed potatoes at home. Moreover, mulching usually results in increased yields if properly handled. Mulching potatoes on a large

scale is of course impracticable, but most farmers could easily mulch enough of their potato field to produce the seed that they would require the following year, and in doing so they would not necessarily increase the cost of production per bushel.

Time to Cut Seed Potatoes.—At least three American experiment stations have conducted tests to learn the effect of cutting seed potatoes several days or weeks in advance of planting. The results varied somewhat according to the length of time that the cut sets remained unplanted, but on the whole indicated no marked difference in productiveness between planting freshly cut pieces and those that had been cut for a week or less. The investigations of Kraus and of Wollny in Germany led to the conclusion that a slight wilting of the seed pieces increased the yield on moist soils and in wet seasons, but reduced it on soils not retentive of water and in dry seasons. On the whole it appears that the storing of cut pieces for several days, which sometimes becomes necessary, is attended with no great disadvantages. Of course due care should be taken in such instances to prevent heating, and it may be well to dust the cuttings with gypsum (land plaster) to prevent excessive wilting.

Seed End v. *Stem End.*—When potatoes are cut in half through their smaller diameter there is a seed or bud end more or less crowded with eyes and a stem or butt end on which there are few eyes. Experiments to determine the relative values of cuttings from the stem end and from the seed end of the tuber have been numerous. The majority of these showed that the yield was greater when the seed end was used. The superior productiveness of the seed end as compared with the stem end was maintained, whether the halves of the potatoes, the thirds, or smaller cuttings were employed.

Effect of sprouting.—The growth of sprouts before planting is made at the expense of the tubers from which they draw their support. Hence if these shoots are rubbed off before planting there is a total loss of the nutriment contained in them. Moreover, numerous weak shoots grow from the injured eye. To prevent these evil consequences of premature sprouting, seed potatoes are stored in a dark, dry, cool place. In spite of all precautions the tubers sometimes sprout; but when practicable only potatoes that have not sprouted should be selected for planting. If the eyes appear dormant in spring, seed potatoes may be exposed to the light and warmth for a few days before planting so as to promote germination and prompt growth. If long exposed, sprouts will form and careful cutting and planting by hand become necessary, so as to avoid breaking of these sprouts.

Quantity of Seed Potatoes per Acre.—A bushel of potatoes (60 pounds) may contain 240 quarter-pound tubers. When the seed pieces are planted a foot apart in 3-foot rows an acre requires 14,520 sets. When tubers averaging 4 ounces are employed an acre requires at these distances 60 bushels for planting whole potatoes, 30 bushels when halves are used, and 15 bushels when quarters are planted. In a number of tests the amount of seed cut to 2 eyes, spaced 1 by 3 feet, averaged 13 bushels per acre, the usual range being from 10 to 14

bushels. In 18 experiments with many varieties the average amount of seed cut to single eyes was at these distances 6.3 bushels per acre, the usual range being from 5 to 7 bushels, though the varieties with large tubers bearing few eyes required considerably more seed.

Size of Seed Pieces.—In the size of the seed piece planted the practice of different farmers varies widely, some advocating a liberal use of seed and others claiming equally good results from small cuttings. To aid in settling this question the State agricultural experiment stations have made numerous tests of seed pieces of different sizes. Taken separately these experiments show certain amount of divergence in results, as might naturally be expected of tests conducted under widely different conditions. However, the majority of these tests, and especially the figures expressing the average results of all available American experiments, may be safely taken as indications of what the farmer, under ordinary conditions, will generally, but not always obtain. The effect of size of seed pieces on yield of crop will be treated here under three distinct heads: (1) On the total yield; (2) on the gross yield of salable potatoes, and (3) on the net yield of salable potatoes, i. e., after deducting the amount of seed planted.

Effect on Total Yield.—In making up the averages below it was found practicable to use the results of 19 tests of single eyes *v.* 2-eye pieces, 4 tests of 2-eye cuttings *v.* quarters, 17 comparisons of quarters and halves, and 44 tests of halves *v.* whole potatoes. The results of other experiments less completely reported were used for the purpose of corroboration. The following table shows the *average* results of these tests, including potatoes of all sizes:

	Bushels.	Per cent.
Excess from use of—		
2-eye pieces over 1-eye pieces	26	21
Quarters over 2-eye pieces	15	16
Halves over quarters	24	18
Whole tubers over halves	31	18

If there are compared all the total yields with the total yield produced by single eyes there appears an increase of 21 per cent for 2-eye pieces, 41 per cent for quarters, 67 per cent for halves, and 96 per cent for entire tubers. The total yield resulting from planting whole potatoes is practically double that obtained by planting single eyes. Thus far there is considered only the total yield, i. e., large and small potatoes, and it is found that the total yield increases somewhat uniformly as the size of the seed piece is increased. The farmer and gardener, however, have to consider other factors than the total yield, for a heavy crop may consist very largely of tubers too small for the market, or the great expenditures for seed when large pieces are planted may more than counterbalance the increased yield. Before noting the gross and net yields of large or salable tubers, resulting from seed pieces of different sizes, it is well to consider the causes inducing a somewhat regular increase in total yield accompanying the use of larger seed pieces.

Several causes operate to increase the yield when large seed

pieces are planted. The larger the cutting the greater generally the number of eyes and the number of stalks. The young shoot, before it develops a strong system of feeding roots, is dependent for nutriment on the material stored up in the seed piece; hence the more abundant this supply the more vigorous the growth of the plant and this increased luxuriance is not confined to the early stages of growth, but is marked throughout the growing season. Investigation has shown that severing the connection between the seed piece and the growing vine, even after the latter is thoroughly rooted, reduces the yield of potatoes. The danger of partial or entire failure resulting from an imperfect stand is much greater with small cuttings than with large seed pieces. The small pieces with extensive cut surfaces are liable to perish should the season be unfavorable, either through excessive moisture or drought. The sprouts from small cuttings being weaker reach the surface with difficulty, or fail entirely on soil not properly prepared.

Effect on Gross Salable Yield.—By averaging the results of the experiments referred to above, it is found that the actual increase in the potatoes of salable size due to using larger seed pieces was as follows, every increase in the size of the seed pieces being followed by an increased gross salable yield:

	Bushels.	Per cent.
Excess from use of—		
2-eye pieces over 1-eye pieces..........	23	21
Quarters over 2-eye pieces.............	10	15
Halves over quarters.................	15	15
Whole tubers over halves............	14	10

Effect on Net Salable Crop.—Before concluding that the largest seed pieces are the most profitable it becomes necessary to deduct from the crop the amount of seed planted. It is plain that the increased amount of seed potatoes required when larger pieces are used may more than counterbalance the increase in yield obtained. The true test of profit is the market value of the crop produced, less the cost of seed planted. Should the quantity of seed potatoes used be subtracted from the total yield of large and small potatoes or from the salable crop? If small or unsalable seed potatoes are planted, then the former course is the proper one, but since large or medium tubers (either entire or cut) are generally selected for seed purposes, it seems best to subtract the seed from the salable crop, thus ascertaining the net salable yield. The following table shows the actual average results for the net salable yield; that is, the crop after deducting the small potatoes and the seed used:

	Bushels.	Per cent.
Excess from use of—		
2-eye pieces over 1-eye pieces........	15.0	14
Quarters over 2-eye pieces.............	7.0	15
Halves over quarters...............	5.0	6
Halves over whole tubers..........	8.5	8

The amount of the net salable crop rose with the increase in the size of the cutting employed, but when the whole potato was planted

the figures declined on account of the large amount of seed potatoes which had to be deducted. The above figures indicate a very slight advantage in planting halves rather than quarters when the price of seed and crop produced are the same. As a matter of fact, spring prices are usually somewhat higher than fall prices. A high price for seed potatoes may make it profitable to plant smaller pieces(as, for example, quarters) than would be economical where seed and crop command the same price per bushel.

Amount of Seed Potatoes.—In the following diagram 100 represents the total yield from planting single eyes. The figures may be read as bushels per acre, if it is constantly borne in mind that there are being considered soils of such character as to average 100 bushels of large and small potatoes per acre when planted with 1-eye pieces. The first group answers the question, "What size of seed piece generally affords the largest yield of large and small potatoes?" The second group answers the query: "What size of seed piece generally gives the greatest yield exclusive of small potatoes?" The third group offers an answer to a still more important question: "What size of seed piece generally produces the largest yield after deducting both the small potatoes and the amount of seed planted?"

Yield from planting different seed pieces, assuming 100 as the total yield from single eyes.

RELATIVE TOTAL YIELD.

1 eye..........	100
2 eyes..........	121
Quarters.......	141
Halves.........	167
Wholes........	196

RELATIVE GROSS SALABLE YIELD.

1 eye..........	87
2 eyes..........	105
Quarters.......	123
Halves.........	142
Wholes........	157

RELATIVE NET SALABLE YIELD.

1 eye..........	83
2 eyes..........	95
Quarters.......	109
Halves.........	115
Wholes........	107

Taking as the correct measure of profit the yield of salable potatoes less the amount of seed used, there is seen by the third section of the diagram that with seed and crop at the same price per bushel it was more profitable in these tests to plant halves than smaller cuttings and whole potatoes. If there be taken account of the yield of small potatoes the advantage of large seed pieces is even greater than the figures in the last section of the diagram would indicate, for the yield of small potatoes is greater with large than with small seed pieces. Where large quantities of small potatoes can be profitably utilized, as, for example, as seed for the second crop, the potato planter may therefore use quite large seed pieces with advantage. On the other hand, the higher price of potatoes in spring rather than in fall is an argument in favor of planting quarters rather than halves or whole tubers. A number of investigators have noted that large seed pieces (either large cuttings or entire potatoes) afford an earlier crop than very small cuttings, a matter of much interest to growers of early potatoes. However, some growers have reported that uncut potatoes germinate more slowly than large cuttings. Most of those who raise potatoes for the early market use large cuttings rather than whole potatoes.

In this connection it may be said that the seed-end half gives an earlier crop than the other half. This suggests the expediency of cutting a potato lengthwise when halves or quarters are to be planted, thus securing on each piece one or more of the eyes which germinate first. Another advantage of cutting lengthwise is that it insures a more even distribution of the eyes on the several pieces. Of course this system is not practicable when very small cuttings are to be made from long, slender potatoes, since the large amount of exposed surface would render the long pieces susceptible to injury both from moisture and dryness.

If it is desired to cut the potato into small pieces the operator should begin at the stem end, and the pieces should be cut in a compact shape, and of as nearly equal size as is practicable without leaving any piece entirely devoid of eyes. There are special implements for cutting potatoes, and their use is reported as enabling a man to cut four or five times as many bushels of seed per day as by hand. The character of the work is said to be satisfactory. No definite rule can be given as to the best size of seed piece, for this depends somewhat on the distance between the hills and on the character of the soil and season. Another important factor in determining the proper amount of seed is variety. Some varieties are able to produce a crop almost as large from small cuttings as from large pieces.

Size of Seed Tubers.—A study of more than a hundred experiments testing the relative values of large, medium, and small uncut tubers confirms the general law that an increase in the weight of seed planted affords an increase in the total crop. The yield of salable potatoes increases less rapidly than the total yield. With whole potatoes as seed the salable yield reached its extreme upward limit in one test when tubers weighing about half a pound were planted; in another when those weighing 4½ ounces were employed. The limit of

profitable increase was reached with tubers weighing 4½ and 3 ounces respectively. The size of seed tubers selected becomes a matter of importance when they are to be cut, for we have seen that the heavier the cutting the larger the total yield, and seed tubers for cutting should be of such size that their halves, quarters, or other divisions shall not be extremely small.

Small Potatoes for Planting.—Whether or not to use uncut small potatoes for seed is an important question on which farmers are divided. Some present the plausible argument that the use of undersized potatoes results in degeneration. If this claim is based on the results of experience it should determine practice, but if the conclusion is simply a generalization based on the fact that large seed usually give best results the reasoning is defective, and the question remains open. The potato tuber is not a seed, but an underground stem, and the relations existing between seeds and their progeny do not necessarily exist between a tuber and its descendants. Others hold that potatoes just below marketable size, if shapely and sufficiently mature, may be used without serious deterioration, and that for economic reasons their use is especially desirable, because if not planted or used at home they must be lost or fed to stock, for which purpose their value is usually smaller than the market price.

The result of tests at a number of experiment stations have uniformly indicated that small tubers uncut can be used for seed purposes without detriment to the succeeding crop. It may still be urged, however, that the choice of small seed year after year will result in degeneration. On this question the information is meager, but two experiments, extending over four and eight years, respectively, have been reported in which no degeneration resulting from the continued use of small potatoes from the preceding crop was apparent. Although the evidence seems fairly conclusive that small uncut seed potatoes may sometimes be used with profit, it cannot be advised that small seed tubers be selected year after year from a crop which has been grown from small potatoes. Potatoes of irregular shape and injured tubers should be rejected as unfit for planting.

Number of Eyes and Weight per Set.—Many potato growers cut tubers into pieces containing one, two, or more eyes, laying greater stress on the number of eyes than on the size of the cutting. Extensive experiments at the Indiana station and elsewhere prove that of the two factors, number of eyes and weight of piece, the latter is the more important. Of course it is desirable that each piece, whether large or small, should contain at least one eye, and it has been generally profitable for it to be of such size as to contain at least several eyes; but whether it has one or many eyes it is important that the seed piece be heavy enough to furnish abundant nutriment to the shoots which spring from it. A single eye may give rise to several stalks, for each eye is a compound bud or cluster of buds. An eye can be bisected, and each half may then grow successfully if it is not a victim to dryness or decay, to which its exposed condition subjects it.

In one series of experiments it was found that the number of

stalks growing in a hill was less dependent on the number of eyes than on the size of the seed piece, whether cut or entire. In general, as the number of eyes per piece increased each eye became less prolific in sending up stalks, so that there was less crowding of stalks where large seed pieces with many eyes were used than would be expected from the large number of eyes planted. After numerous experiments touching on almost every aspect of this subject the investigator advised that tubers be cut so as to make each piece of a constant size or weight, whatever the number of eyes that might fall to its share.

Cuttings per Hill.—A custom not uncommon among those who plant small cuttings is to drop two pieces in each hill. They usually get a larger yield by so doing than by planting single pieces, the increase generally, though not always, being sufficient to pay for the excess of seed. This does not prove the practice profitable, for better results may be secured by planting a single piece weighing as much as the combined weight of the two pieces which would have been dropped in one hill. Thus the labor of cutting is considerably reduced and, what is more important, larger pieces improve the chances of getting a good stand in an unfavorable season, because they have less exposed surface than two small pieces of equivalent weight, hence are less liable to dry out excessively when drought follows planting. They are also better able to resist rotting if wet weather prevails.

Stalks per Hill.—The most common objection urged against planting large seed pieces is, next to the expense, the danger of having the hills so crowded with stalks, and consequently with tubers, that a large proportion of the potatoes never develop to marketable size. This objection is probably valid for entire tubers, and also for halves planted very close in the row. The evidence available does not permit us to conclude that in the case of quarters used as seed there results any injurious crowding, and it may be questioned whether halves give rise to this trouble when planted under favorable conditions and at considerable distance apart. The number of stalks that can be advantageously grown in each hill varies greatly with variety, season, soil, and distance apart.

Distance Between Plants.—In deciding on the proper distance at which to plant potatoes it is necessary to take into consideration the size of the seed piece that is to be employed. In general, small seed pieces should be planted close and the distance allotted to each hill should be greater as the weight of the piece is increased. Close planting for small cuttings is best attained, not by narrowing the row to less than about 2½ or 3 feet (for if the distance is much less horse cultivation becomes difficult), but by planting the seed pieces close together in the row. To frame a general rule giving best distances for seed pieces of different sizes is plainly impossible, for the distance at which the largest yields is obtained depends also on the variety, the season, the soil, and the fertilizers. However, the results of some of the investigations covering this matter afford help in deciding on the proper distance under varying conditions. It has been

shown that if very small cuttings are used, and if the soil is fertile, the distance can be reduced to 6 or 9 inches without sacrificing the yield, provided the season happens to be favorable, but this is not generally advisable.

On rich soil cuttings of considerable size can be advantageously planted as close as 12 inches. Checking effects a saving of labor in cultivation, and also in planting and harvesting, when these latter operations are performed by hand; hence expensive labor and the absence of machines for planting and harvesting the crop are conditions in favor of checking. For planting in checks a variety can be chosen which makes a large growth of vines and which forms many tubers in each hill, thus more completely utilizing the space at its disposal than could a variety with small vines and few tubers. In checking there is danger on rich soil that some of the tubers may grow to an objectionable size. Potato growers in attempting to obtain a phenomenal yield, as in contests for prizes, almost universally plant in drills rather than in hills, and place the seed pieces from 8 to 15 inches apart. The advocates of planting in drills claim that by this method a larger yield can be obtained, and experience seems to confirm the correctness of this view. The few experiments that have been made on this question are not entirely conclusive, though the majority of them favor drills. Although no fixed rule regarding distance of planting can be given, the following general considerations are widely applicable:

(1) For maximum yield of salable potatoes plant in rows as narrow as can be conveniently cultivated.

(2) Crowd small seed pieces close together in the row, increasing the distance with every increase in the size of the seed piece; avoid on the one hand such close planting as to greatly reduce the average weight of the tubers, and on the other such wide spacing as to leave any considerable portion of the soil unshaded by the full-grown vines.

(3) As a rule, the richer the land the less the required distance between sets.

(4) Varieties with strong growth of vines or which set many tubers in a hill should have greater distance between plants than is necessary with less vigorous varieties.

Cultivation.—Soon after planting, and again just as the young plants are beginning to appear above ground, the field should be harrowed, inclining the teeth of the harrow backward. This is a cheap method of cultivation, since a wide space is covered. It is also effective in destroying small weeds, in leveling the ridges left in planting, in preventing the formation of a surface crust, and in keeping the land covered with a mulch of dry earth, thus conserving moisture within the soil below. Subsequent cultivation should be frequent so as to accomplish these same ends. Almost any pattern of cultivator may be used, provided it is made to do shallow work. However, if the ground has become packed the first cultivation may be deeper. Experience and exact experiments generally favor flat or nearly flat cultivation. Excessive hilling during cultivation intensi-

fies the injurious effects of dry weather. It also results in breaking many of the feeding roots between the rows. The frequent use of the cultivator should be substituted as far as possible for hoeing. If a severe frost is apprehended soon after the plants come up, the tops should be covered by throwing a furrow to each row.

Mulching.—While mulching with hay, straw, leaves, or other litter frequently increases the yield and is specially valuable in tiding over a season of drought, it is not generally practicable on farms where potatoes are grown on a large scale. Its place is in the garden rather than in the field. It is a substitute for cultivation, and it is generally cheaper to maintain a soil mulch by frequent cultivation than to apply litter. If a mulch is employed, it can be applied over the entire surface or in the furrow above the seed pieces, or between the rows. Mulching in the furrow is not commended by the results of tests in Colorado, Louisiana, and Michigan. In striving for a large yield, with little regard to cost, or to insure against drought, mulching is useful.

Material intended to serve as a mulch should first be exposed to the weather, so as to cause the sprouting of any seed it may contain. It is better to apply a mulch after potato plants have made some growth, as an earlier application may result in smothering some plants and in injury from late frosts.

Harvesting and Storing.—The death of the vines is the signal for digging the main crop. For the early market potato growers do not wait for this, but are governed by the size of the tubers. As long as any portion of the vine is green the tubers can continue to grow. In gardens very early potatoes are sometimes obtained by carefully removing a few of the larger tubers from the growing plant, replacing the soil and allowing the smaller potatoes to continue growing ("grabbing"). The large amount of labor required prohibits "grabbing" except when early potatoes are selling at a price very much higher than can be expected from the later crop.

In harvesting a large area a high-priced potato digger is frequently used; hand digging with a four-tined fork is probably the best method on small areas, though many make use of a potato hoe or of a plow. Careful handling always pays, and extreme carefulness is necessary, especially with the early crop, to prevent injury to the tender skin of the immature potatoes. In harvesting, as well as in storage, potatoes should be exposed to light as little as possible. In storing potatoes a low temperature is required. The potato tuber is uninjured by a temperature of 33° F., and one authority gives the freezing temperature of potatoes 30.2° F. Warmth favors sprouting, which injures potatoes both for planting and eating.

Most of the farmers have potato houses or cellars constructed for storing their stock and holding the unsold portion of the crop through even the coldest weather until they can market it. Some growers, especially those near town, depend on the warehouses of the dealers alongside the railroad tracks. The common type of storehouse on the farm is a cellar walled up with concrete or stonework, about 8 or 9 feet deep, with a low wooden roof above it, giving a con-

siderable space for the storage of tools, barrels, etc., on the floor above the cellar portion. These cellars are usually built on the side of a hill, so that the potatoes are unloaded down through the floor in the fall and taken out at a lower doorway during the winter.

Grading.—The grading of early potatoes is quite as important as the grading of fruits. Large and small tubers should not be mixed in the same barrel. The pickers should be taught to gather the large and merchantable tubers in one basket and the small or seed potatoes in another, and these if placed upon the market should go in separate receptacles and be clearly marked so as to represent the grade. If a mechanical sorter is used this work will be more effectively accomplished than if left to the pickers. The type of grader usually used is similar to that employed in some sections for grading apples and peaches, although the common type of potato grader is a rotary screen which separates the earth from the tubers and allows the small tubers to fall through the large meshes of the screen before reaching the general outlet which carries away those of merchantable size. The objection to a mechanical grader of this type is that it bruises the immature tubers and renders them somewhat less attractive than when not so handled and probably also shortens the length of time they can be safely held on the market.

Marketing.—The perishable nature of the immature potato renders it necessary to place it upon the market in such quantities only as will admit of immediate consumption. Producers in regions where the growing of early potatoes has been extensively developed appreciate this and have provided for this condition by organizing shippers' associations through which the crop is graded, often trademarked, and distributed chiefly in carload lots. The officers of the association being in constant telegraphic communication with the various markets are thus informed regarding the most satisfactory destination for every consignment which may be necessary. It is the purpose of these associations, however, to conduct their business in such a way that the product can be sold f. o. b. shipping point instead of by consignment, and the best organized associations are usually able to do this.

The great advantage of such a system of selling is that it enables the brokers in a small city or town to buy direct from the producer instead of through another city broker. It enables the consumer to obtain fresh products, as they are shipped direct from the point of production to the place of consumption. The plan carries other benefits which are of great moment to the producer. He is enabled to sell in carload lots at shipping point, thus saving to himself the cost of transportation, which ranges from 7 to 15 per cent of the gross selling price. The exchange secures a much wider distribution of the crop, with the result that overstocked markets are much less likely than under the consignment system. Transportation companies provide better service, and claims are more promptly settled through the exchange than in the case of individuals. This plan enables the producer to be his own salesman. It transfers the distributing point from the city to the field, where it should be. It brings the market to

the fields instead of the product to the market. The exchange becomes the farmer's commission house, and it is much easier to keep informed regarding the transactions of a home association than of a foreign concern.

Varieties.—The following are among the most widely known varieties: *Early,* Early Ohio, Early Rose, Beauty of Hebron, and Triumph. *Medium and late,* Burbank, Rural New Yorker No. 2, Empire State, Mammoth Pearl, White Star, and Dakota Red. These are standard varieties, and though not necessarily the best, they seem to have given general satisfaction.

Second-Crop Potatoes for Seed at the South.—Within recent years there has been a marked increase in the use of second crop potatoes for seed throughout the southern potato-growing sections. This crop is frequently grown on the same land from which the first crop of potatoes was harvested. In most instances, however, it follows beans or cucumbers, as the seed for this second potato crop is not usually planted until July or August. The seed for this crop is, as a rule, saved from the early crop, the small tubers being stored in a well-ventilated shed, where they are protected from the direct action of the sun and from storms until about ten days or two weeks before the time of planting, when they are spread thinly upon the ground and lightly covered with straw or litter to partially protect them from the sun. Under these conditions the tubers quickly "green" and all those suitable for seed will develop sprouts. As soon as the sprouts are visible, and before they are large enough to be rubbed off in handling, the potatoes are ready to plant. The product of this planting gives a crop of partially matured tubers which are held over winter for spring planting. This practice gives excellent results in many localities and is found to be more economical than the purchase of northern-grown seed. To what extent it is safe to follow this practice without renewing the seed from the North by the use of fully matured tubers has not been determined. Those following the method should carefully observe the quality and yield of the crop for the purpose of determining whether or not it is deteriorating under this treatment. In general, it is believed that it will be within the limits of good practice to secure every second or third year enough northern-grown seed to supply seed for the second crop; in fact, some of the most successful growers of potatoes who use second-crop seed get enough northern-grown seed each year to supply planting material for the second crop. In this practice it will be economy to err on the side of safety and obtain fresh seed frequently from reliable northern sources. In a majority of instances it is found that second-crop home-grown seed is slower to germinate and later in maturity than northern-grown seed, and as quick development is an important element in the crop at the South, growers are urged to consider this point carefully.

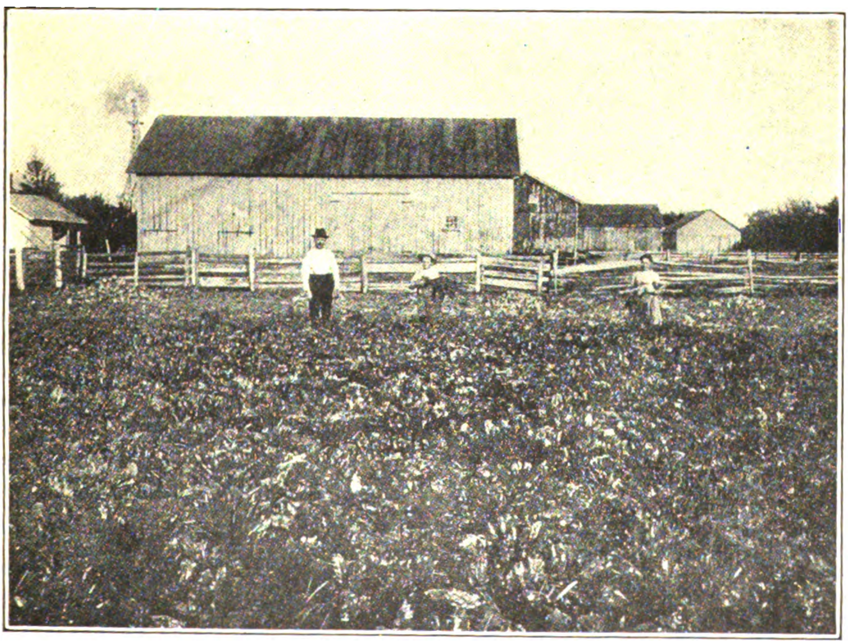
Held-over Seed.—The consensus of opinion is that in southern localities it is impracticable to keep early potatoes from harvest time to the next season's planting period. The conclusions of those who have given this problem careful study are that the exposure of the

tubers to the sun at harvest time is the chief factor in determining their keeping qualities. In other words, it is possible to keep potatoes in the extreme South from season to season provided the tubers are not exposed to the sun after being dug. They should be immediately carried to a protected place where there is ample ventilation and where they will receive only diffused light, such as a cyclone or other cellar, or the basement of a house, or even where brush protection will prevent the sun shining directly upon them. It is, of course, necessary that the tubers be well matured before being dug and that they be the product of disease-free plants. Plants killed by blight yield tubers which seldom keep well even under the most favorable conditions.

Methods of Securing Extra-Early Potatoes.—One of the most important factors having an influence on the profitableness of market garden crops is that of earliness. A difference of two or three days or a week in placing a crop on the market often makes the difference between profit and loss, and the prices obtained for extra-early crops have stimulated cultural experiments with every kind of fruit and vegetables. Some interesting results along this line with potatoes have recently been reported by the Kansas and Rhode Island stations. At the Kansas Station seed tubers of four different varieties of medium-sized potatoes were placed in shallow boxes with the seed ends up in February. They were packed in sand, leaving the upper fourth of the tubers exposed, and the boxes were placed in a room with rather subdued light, having a temperature of 50° to 60° F. Vigorous sprouts soon pushed from the exposed eyes. The whole potatoes were planted in furrows in March in the same position they occupied in the boxes. The same varieties of potatoes taken from a storage cellar were planted in parallel rows. The sand-sprouted potatoes took the lead from the start in vigor and strength of top and produced potatoes the first of June, a week earlier than the storage-cellar potatoes. At the final digging they showed better potatoes and gave a 10 per cent larger total yield. In other experiment part of the potatoes was treated the same as in the first test, except that the sand was kept moistened, and the other part was placed in open boxes and kept in a light room having a temperature of 50° F. The tubers placed in sand developed strong sprouts and nearly all rooted. When planted in the field they outstripped both the tubers sprouted in open boxes and the storage-cellar tubers in vigor of growth. The tubers started in the open boxes gave earlier yields than were obtained from the storage-cellar tubers, but not as early as the tubers sprouted in moist sand. The tubers sprouted in moist sand produced table potatoes from 7 to 10 days earlier than the storage-cellar seed.

At the Rhode Island Station medium-sized whole potatoes sprouted on racks, in a fairly warm and light room, gave a 27 per cent better yield at the first digging than potatoes kept in a cold cellar until planting time; and this was increased to 40 per cent at the final digging. The percentage of large tubers was also greater at each digging with the sprouted tubers. The results of these experi-

A Field of Sugar Beets Ready for the Factory. at Blissfield, Mich.
Year Book, 1903.



Corner of a 12-Acre Field of Sugar Beets at Blissfield, Mich.
Year Book, 1903.

ments are suggestive. The handling of seed potatoes in such manner as to secure strong, stocky sprouts before the tubers are planted out is shown to be an important factor in increasing both the earliness and the total yield of the crop. By planting only well-sprouted seed, a full stand is assured.

One of the objections to this method of growing potatoes is the large amount of space required for exposing the tubers to the light for sprouting. This objection has been overcome in part by the use of trays and racks. At the Rhode Island Station the rack used held 9 trays. Each tray was 3¾ feet long and 1½ feet wide, and would hold about 1 bushel of potatoes when spread out in a single layer for sprouting. The bottoms of the trays were made of pieces of lath placed about 1 inch apart. Nine trays were placed in a rack over each other, leaving about 9 inches of space between each tray. This method of arrangement has the advantage of securing a very uniform distribution of light, heat, and air for all the trays. It greatly facilitates the handling of the potatoes and lessens the danger of breaking off the sprouts and transferring to the field for planting.

Another method of securing early potatoes in Rhode Island on a commercial scale is that of sprouting tubers in a cold frame and planting out as soon as danger of frost is past. The tubers are cut into pieces, not smaller than an English walnut, after rejecting the two or three eyes nearest the stem end, which have been found to start late. The pieces are placed side by side in the bed, skin side upward, and covered about 4 inches deep with fine, rich earth. Their growth can be controlled by proper regulation of the cold-frame sash. At planting time the tubers, the sprouts of which should be just breaking the surface of the soil, are carefully lifted with manure forks, separated by hand, and placed in well-fertilized rows, and entirely covered with soil; or, if danger of frost is past, they are placed with the apex of the sprout just at the surface of the soil. About 216 square feet of cold frame is required to sprout sufficient potatoes to plant an acre in 30 to 32 inch rows, 12 inches apart. Eight men can transplant an acre in a day.

On the Island of Jersey, where early potatoes are raised in large quantities for the London market, the potatoes destined for seed are placed side by side in shallow boxes and stored, as soon as cold weather sets in, in a light and well-sheltered loft or shed, out of danger of frost. The position of the boxes is changed from time to time so that the sprouts will be of equal length and strength at the planting season. Medium-sized tubers selected from the best of the crop and allowed to lie in the field in the fall until they become greenish are used.

Potatoes on Western Irrigated Farms.—With thorough cultivation, for potatoes planted the first of May, irrigation is seldom necessary until July. Generally speaking irrigation water is cold and it is highly important not to irrigate too frequently, since the water not only causes the soil to run together but lowers the temperature to a point that is not favorable to the growth of potatoes. Irrigation water is applied only when the condition of the plants indicates that

they are in need of water, as by darkening of the foliage. Or one may dig down in the hill and press a handful of soil in the hand; if it fails to retain its form, irrigation is needed. Care should be taken not to wait until the ground is too dry, because one can not cover the whole field of potatoes in one day's irrigation, and some are likely to suffer for water before being reached. Experience shows that if potatoes are grown as rapidly as possible, so as to become strong and well established early in the season, they withstand the maximum of unfavorable weather conditions later on, when the hot dry winds becomes a menace to the crop.

When the time for irrigation arrives, a V-shaped trench halfway between the rows should be opened in alternate middles with an 8 or 10 inch lister plow; that is, a narrow plow with a double moldboard which throws the dirt each way. In these furrows the irrigation water is run so that the soil will not become solidified by flooding, and the necessary amount of water may be properly distributed. For the second irrigation furrows are opened in the middles that were not opened at the first irrigation, and this alternation is continued for succeeding irrigations. At the head of each field is a feeder ditch from which the water is admitted to these irrigation furrows between the rows. It is essential that the right quantity of water be used, and that it be uniformly distributed. Cultivation should commence as soon after irrigation as the soil will permit so as to insure rapid and uniform growth without check. This will not only result in the production of smooth, uniform tubers of attractive appearance, which are always in demand at high prices, but will also result in large, profitable yields and at the same time keep the soil in good mechanical condition for future crops. Do not irrigate after August 10, so as to give fifty or sixty days for ripening in dry earth.

There is no line of farming in the irrigated districts that gives such marvelous profits as that of scientific potato production. With scientific knowledge which can certainly be acquired by experiments in supplying perfectly balanced plant food and maintaining soil fertility, the scientific principles of which are similar to those used by every successful breeder in feeding and fitting prize-winning stock; and with the proper proportions of plant foods—phosphates, nitrogen, and potash—in the soil as found in many parts of the West; and by the use of clover and alfalfa, there is no reason for those who contemplate engaging in the potato industry to fear the outcome. Too much stress can not be put upon the value and importance of live stock in keeping up favorable soil conditions, as no country now known has been continuously successful in crop production without the use of manures from the feeding of forage and grain crops.

Varieties.—Years of experience have demonstrated that comparatively few varieties of potatoes are really adapted to western or mountain conditions. Among the early varieties none has been so universally successful as the Early Ohio. This potato is of fine quality and uniform in size and shape, though not a heavy yielder. Another good potato, though not so early, is the Rose Seedling. For

a medium to late variety, the Dalmeny Challenge, a Scotch variety, is being used quite extensively on the western slope of Colorado. For later varieties, the White Pearl and Rural New York No. 2 are more extensively used at Greeley, in the San Luis Valley, and in the Uncompahgre Valley; and the Perfect Peachblow is the favorite in the upper Grand Valley.

PUMPKIN.

The true pumpkin is hardly to be considered as a garden crop, and, as a rule, should be planted among the field corn. Plant where the hills of corn are missing and cultivate with the corn. However, some of the better sorts of pie pumpkins should be grown in the garden for cooking purposes, because they are productive and much superior in quality to the common field pumpkins.—(F. B. 255; Mich E. S. 20, 190.)

RADISH.

The radish is quite hardy and may be grown throughout the winter in hotbeds at the North, in cold frames in the latitudes of Washington, and in the open ground in the South. For the home garden the seed should be sown in the open ground as soon as the soil is moderately warm. Plant in drills 12 to 18 inches apart, and as soon as the plants are up thin them slightly to prevent crowding. Radishes require to be grown on a quick, rich soil, and some of the earlier sorts can be matured in two to three weeks after planting. If the radishes grow slowly they will have a pungent flavor and will not be fit for table use. For a constant supply successive plantings should be made every two weeks, as the roots lose their crispness and delicate flavor if allowed to remain long in the open ground. As a rule a large percentage of radish seed will grow, and it is often possible by careful sowing to avoid the necessisity of thinning, the first radishes being pulled as soon as they are of sufficient size for table use, thus making room for those that are a little later. Radishes will not endure hot weather and are suited to early spring and late autumn planting. There are a number of varieties of winter radishes, the seed of which may be planted the latter part of summer and the roots pulled and stored for winter use. These roots should remain in the ground as long as possible without frosting and should then be dug and stored the same as turnips. This type of radish will not compare with the earlier summer varieties, which may be easily grown in a hotbed or cold frame during the winter. One ounce of radish seed is sufficient to plant 100 feet of row, and when grown on a large scale 10 to 12 pounds of seed will be required to the acre.—(F. B. 255, 295; U. Id.. E. S. 10; Mich. E. S. 20; N. Car. E. S. 132.)

RHUBARB (PIE PLANT).

The soil for rhubarb should be deep, and there is little danger of having it too rich. Like asparagus the seedling plants of rhubarb can be grown and transplanted. Ten to twelve good hills are sufficient to produce all the rhubarb required by the average family, and these are most easily established by planting pieces of roots taken from another bed. Good roots may be secured from dealers and seedsmen at about $1.50 a dozen. The old hills may be divided in

the early spring or late fall by digging away the earth on one side and cutting the hill in two with a sharp spade, the part removed being used to establish a new hill. The usual method of planting rhubarb is to set the plants in a single row along the garden fence, and the hills should be about 4 feet apart. If more than one row is planted the hills should be 3½ or 4 feet each way. The thick leaf stems are the part used, and none should be pulled from the plants the first year after setting. Rhubarb should receive the same treatment during winter as asparagus, and the plants should never be allowed to ripen seed. The roots may be brought into the greenhouse, pit, cold frame, or cellar during the winter and forced. Rhubarb does not thrive in warm climates. The use of rhubarb is principally during the early spring for making pies and sauces, and the stems may be canned for winter use.—(F. B. 255; N. Car. E. S. 132; U. Id. E. S. 10.)

RUTA-BAGA (SWEDES).

The culture of the ruta-baga is the same as for the turnip, except that the former requires more room and a longer period for its growth. The roots are quite hardy and will withstand considerable frost. The ruta-baga is used like the turnip, and also for stock feed. Two pounds of seed are required for one acre.—(F. B. 255; Mich. E. S. 6.)

SALSIFY (VEGETABLE OYSTER).

Sow seeds of salsify during the spring in the same manner as for parsnips or carrots. At the South, a sowing may be made in summer to produce roots for winter use. One ounce of seed is required to plant 100 feet of row, and on a large scale 10 pounds to the acre. After the plants are well established they should be thinned sufficiently to prevent their crowding. The cultivation should be the same as for parsnips or carrots, and frequent use of a wheel hoe will avoid the necessity for hand weeding. Salsify may be dug in the autumn and stored or allowed to remain in the ground during the winter, as its treatment is the same as for parsnips. Salsify is a biennial, and if the roots are not dug before the second season they will throw up stems and produce seed. It is of a weedy nature and care should be taken that it does not run wild by seeding freely. Salsify is deserving of more general cultivation, as it is one of the more desirable of the root crops for the garden. The uses of salsify are similar to those of the parsnip, and when boiled and afterwards coated with rolled crackers and fried in butter it has a decided oyster flavor, from which the name vegetable oyster is derived.—(F. B. 255, 295; N. Car. E. S. 132; Idaho E. S. 10.)

SCOLYMUS.

Scolymus is a vegetable with spiny, thistle-like leaves, from Spain, with roots much like a small parsnip and keeping equally well in winter.—(S. Dak. E. S. 68.)

SKIRRET.

This is called "Zuckerwurzel" (Sugar root) in Germany. The plump, fleshy roots are sweet and used boiled during winter, the same as Salsify.—(S. Dak. E. S. 68.)

SORREL.

This plant resembles the weed "sour dock" of the fields. The leaves are large, tender and juicy, very broad and often 10 inches long, retaining the pleasant acid flavor of the original weed. Much prized in France where it is cultivated as a spring vegetable and used singly or mixed with spinach.—(Mich. E. S. 20; U. Idaho E. S. 10.)

SPINACH.

Spinach thrives in a rather cool climate and attains its best development in the Middle South, where it can be grown in the open ground during the winter. Large areas are grown near Norfolk, Va., cuttings being made at anytime during the winter when the fields are not frozen or covered with snow. When the weather moderates in the early spring the plants make a new growth, and a large crop of early greens is available. North of the latitude of Norfolk, spinach can be planted in the autumn and carried over winter by mulching with straw or leaves. Sow the seeds in drills 1 foot apart at the rate of 1 ounce to 100 feet of row or 10 to 12 pounds to the acre. To produce good spinach, a rich loam which will give the plants a quick growth is required. As ordinarily grown, it occupies the land during the autumn and winter only and does not interfere with summer cultivation. It is an easily grown garden crop, and there is, perhaps, no other of its kind that will give as good satisfaction. Three or four ounces of seed, planted in the autumn after a summer crop has been harvested from the land, will produce an abundance of greens for the average family during the late autumn and early spring. In gathering spinach the entire plant is removed rather than merely cutting off the leaves. The larger plants are selected first, and the smaller or later ones are thus given room to develop. No thinning is required if this plan of harvesting is practiced.—(F. B. 255; Mich. E. S. 20; U. Id. E. S. 10; N. C. E. S. 132.)

SQUASH.

There are two types of the squash, the bush varieties, which may be planted in hills 4 or 5 feet apart each way, and the running varieties, which will require from 8 to 16 feet for their development. Squashes may properly be grown in the garden, as 3 or 4 hills will produce all that are required for family use. They require practically the same soil and cultural methods as the muskmelon. A number of varieties are used during the summer in the same manner as vegetable marrow, but squashes are principally used during the winter, in much the same way as pumpkins, to which they are superior in many respects. Squashes are also used extensively for pie purposes. The varieties known as Hubbard and Boston Marrow are most commonly grown. Squashes, like pumpkins, should be handled carefully to avoid bruising, and should be stored in a moderately warm but well ventilated room.—(F. B. 255; Mich. E. S. 190; S. Dak. E. S. 42, 68.)

STACHYS.

This vegetable, known to the botanists as *Stachys sieboldi,* has been introduced into America from Japan and has a number of different names, such as Japanese potato, Chinese artichoke, chorogi,

etc., but the name stachys seems to have been adopted as the common one in this country. The plant is a small perennial belonging to the mint family and produces just below the ground a multitude of small, white, crisp edible tubers, varying from an inch to two and one-half inches in length, and about one-half an inch in thickness and marked by irregular spiral rings, which give them a corkscrew-like appearance.

Stachys has been tested at the New York (Cornell) and a number of the other agricultural experiment stations, and proved so easy of cultivation and pleasant in taste (the flavor resembling artichokes) that the vegetable has made many friends and is now procurable at the markets in most of our larger cities. The agreeable quality is in considerable measure due to the crispness of the tubers, and as this disappears when they are exposed to the air they should be stored in sand or sawdust. They are ready for use when the plant dies down in the autumn, though they may be easily carried over the winter and are prepared for the table like potatoes or other vegetables, or may be eaten raw like radishes.—(F. B. 295.)

SWEET BASIL.

The leaves are used for flavoring purposes.

SWEET CORN.

Plant sweet corn as soon as the soil is warm in the spring, and make successive plantings every two weeks until July, or the same result can be attained to some extent by a careful selection of early, medium, and late varieties. Plant the seeds in drills 3 feet apart and thin to a single stalk every 10 to 14 inches, or plant 5 to 6 seeds in hills 3 feet apart each way, and thin out to 3 to 5 stalks in a hill. Cover the seeds about 2 inches deep. Cultivate frequently and keep down all weeds, removing suckers from around the base of the stalk.

Sweet corn should be planted on rich land, and the method of cultivation is practically the same as for field corn, but should be more thorough. There are a number of good early varieties, and for a midsummer and late sort there is none better than Stowell's Evergreen.—(F. B. 255; N. J. E. S. 199; S. Dak. E. S. 91.)

SWEET MARJORAM.

Leaves and ends of shoots used for seasoning.

SWEET POTATO.

Owing to the tropical nature of the sweet potato it naturally thrives best in the South Atlantic and Gulf Coast States, but it may be grown for home use as far north as southern New York and westward along that latitude to the Rocky Mountains. The climatic requirements for the production of sweet potatoes on a commercial scale are (1) a growing period of at least four and half months without frost, (2) warm nights and abundant sunshine during the day, and (3) a moderate rainfall during the growing period. Where irrigation is depended upon for the supply of moisture, the greatest quantity of water should be applied between the time the plants are set in the field and the time when the vines practically cover the ground. If too much water is applied during the latter part of the

season the result may be an abundant growth of vine and a small yield of stringy potatoes. For some time before harvesting the crop the water should be withheld altogether, in order that the roots may ripen properly.

Soil.—Sweet potatoes thrive on a moderately fertile sandy loam which does not contain an excess of organic matter. They are frequently grown upon almost pure sand, especially where the subsoil is a yellow clay. Soils containing considerable calcium or underlain with limestone are well adapted to the growing of the crop. The sweet potato is exceptional in that a fairly good crop can be grown upon soils that are too poor for the production of the majority of farm crops. Sweet potatoes yield a fair crop on the "worn-out" tobacco and cotton lands of the South, especially when used in a rotation including some leguminous crop for increasing the humus in the soil. Like many other crops, the sweet potato thrives on newly cleared land, but the crop should not be planted continuously in the same place. With the sweet potato, as with other crops, rotation is the keynote of success.

Good drainage is essential, the original idea of planting upon high ridges being for the purpose of securing better drainage. The surface soil should extend to a depth of 6 or 8 inches, and the subsoil should be of such a nature that it will carry off excessive moisture without leaching away the fertilizers applied to the land. Too great a depth of loose surface soil or an alluvial soil having no subsoil will produce long, irregular potatoes that are undesirable for marketing. Planting upon land having a loose, sandy surface soil underlain by a well-drained clay subsoil will tend to produce the type of rather thick, spindle-formed potato that commands the highest price. The depth of plowing is a prominent factor in the preparation of land for sweet potatoes, and on soils of too great depth before the subsoil is reached very shallow plowing should be practiced, leaving the soil firm beneath, against which the roots must force their way. If the surface soil is of insufficient depth, it should be gradually increased by plowing a little deeper each year or by subsoiling in the furrow behind the regular turning plow.

Fertilizers.—The root portion of the plant is the part having the greatest value, though the foliage and vines have some value as food for certain kinds of stock. It has been found that an excessive amount of organic matter in the soil will frequently produce an abundant growth of vines at the expense of the roots. It has also been noted that the potatoes will be small and the yield unsatisfactory on soils that do not contain sufficient organic matter to produce a fair growth of vine. The use of stable manure as a fertilizer for sweet potatoes is recommended on lands that are deficient in organic matter. Heavy applications of fresh manure shortly before planting the land to sweet potatoes will stimulate not only the growth of weeds but also of the vines at the expense of the roots. Well-rotted stable manure may be used at the rate of 10 to 15 carloads to the acre, spread broadcast or beneath the ridges and harrowed into the soil, but it is always well to apply the manure with the crop grown the previous season.

By this method the manure will become thoroughly incorporated with the soil and become somewhat reduced before the sweet potatoes are planted upon the land. Stable manure will be found most beneficial on worn-out soils, but on the more fertile soils its use should be retsricted and the method of application carefully studied.

The sweet potato is one of the few crops that thrive equally as well (or better) upon commercial fertilizers as upon stable manure. A fertilizer for use on the majority of sweet potato lands should contain 3 to 6 per cent of nitrogen, 6 or 7 per cent of phosphoric acid, and 8 to 10 per cent of potash. Every grower should make a study of the requirements of his soil and apply the fertilizer that will give the best results. Many growers purchase the ingredients and mix their own special fertilizers, or use a standard fertilizer as a base and increase the percentage of certain elements by adding high-grade elementary ingredients. Some soils require that certain elements should be in a more available form than others; in the case of nitrogen it is often desirable to have a portion of that contained in the fertilizer quickly available and the remainder more slowly in order to feed the plants throughout the season. A mixture adapted to the growing of sweet potatoes on most soils may be made by combining the following:

200 pounds of high-grade sulphate of ammonia, 25 per cent pure.
200 pounds of dried blood, or 300 pounds of fish scrap.
1,200 pounds of acid phosphate, 11 per cent pure.
400 pounds of high-grade muriate of potash, 50 per cent pure.

The quantity of fertilizer that may be profitably applied will be governed entirely by local conditions. Many growers do not depend upon commercial fertilizers, but merely apply from 200 to 300 pounds to each acre as a supplement to the organic matter and natural fertility of the soil. Others apply from 300 to 1,000 pounds, according to the condition of the soil, while a few growers use a ton to the acre. The general rule is to apply the fertilizer in the row where the crop is to be grown, but where large quantities are used it should be distributed at least ten days before planting and thoroughly incorporated with the soil. An application of 1,000 pounds of high-grade fertilizer placed in the row at planting time has been known to injure seriously or kill the plants. For the best results the fertilizer should be applied at least ten days before planting, or a portion of the fertilizer may be applied a month or more in advance and the remainder at the time of preparing the land for planting. Hardwood ashes are desirable for use on sweet potato land and may be applied at the rate of from 1,200 to 2,000 pounds to the acre. The value of wood ashes depends upon how much they have become leached, but hardwood ashes should contain from 6 to 8 per cent of available potash. Wood ashes also contain considerable lime.

Where large quantities of any green crop are plowed into the soil there is a tendency to sourness, and occasional applications of from 1 to 2 tons of lime to the acre are beneficial. The presence of an abundance of lime in soils devoted to the growing of sweet potatoes hastens the maturity of the crop and increases the yield. On

poor soils the lime and potash work together to produce potatoes of uniform size and shape, but on rich or alluvial soils the tendency is toward the production of over-large and irregular roots. The lime should be applied the previous season, or at least the autumn before planting the land to sweet potatoes.

Propagation of Plants.—The more common varieties of the sweet potato have for a great many years been propagated by cuttings, or sets, taken either from the potatoes themselves or from growing vines, and as a result the plants have ceased to flower and produce seed. The greater portion of the commercial crop is grown from sets, or "draws," produced by sprouting medium-sized potatoes in a warm bed of soil.

Where only a small area of sweet potatoes is to be grown for home use, the necessary plants can generally be secured from some one who makes a business of growing them. If an acre or more is to be planted it will in most cases be more economical to prepare a bed and grow the plants. The method of starting the plants will depend upon the locality and the acreage to be planted, the essentials being a bed of warm earth and a covering to protect the young plants during the early springtime.

Selection of Seed.—The potatoes that are to serve as seed from which to grow the plants for the next season's crop should always be selected at the time of digging and housing the crop. For seed purposes it is the custom to select the medium or under-sized potatoes, such as are too small for marketing. Those potatoes that will pass through a 2-inch ring or can be circled by the thumb and first finger of a man having a hand of average size are used for seed purposes.

The seed potatoes should be uniform in size and of the shape desired in the following year's crop. The seed should be free from cuts, bruises, decay, or disease of any kind. Throughout the handling of the seed potatoes they should not receive any treatment that would break eggs. The seed should always be handled and kept separate from the regular crop. The oftener the seed is handled the greater the danger of decay, and it should not be sorted over until everything is ready for bedding. The best seed is grown from cuttings taken from the regular plants after they have begun to form vines. These cuttings produce large numbers of medium or small-sized potatoes that are free from diseases and adapted for use as seed the following year.

Hotbeds.—Toward the northern part of the area over which sweet potatoes are grown it is necessary to start the plants in a hotbed in order that the length of season may be sufficient to mature the crop. The roots that are too small for marketing are used for seed, and these are bedded close together in the hotbed and covered with about 2 inches of sand or fine soil, such as leaf mold. The seed should be bedded about five or six weeks before it will be safe to set the plants in the open ground, which is usually about May 15 or May 20. Toward the last the hotbed should be ventilated very freely in order to harden off the plants.

Drawing the Sets.—As a general rule sweet potato plants are set

in the field shortly after a rain. In order to avoid delay in planting, the hands should begin to get out the sets as soon as the rain ceases falling and place them in crates or baskets ready for transportation to the field. The sets are not all produced at once, and only those that have formed good roots are "drawn," the others being left until later. In drawing the sets the seed potato is held down with one hand while the plants are removed with the thumb and finger of the other hand. It often happens that five or six plants will cling together at the base, and these should be separated in order to avoid loss of time in the field. The roots should all be kept in one direction, and if the tops are long or irregular they may be trimmed off even by means of a knife. While drawing the sets it is a good plan to have at hand a large pail or tub containing water to which there has been added a quantity of clay and cow manure which has been stirred until it forms a thin slime. As the plants are pulled from the bed they are taken in small bunches and their roots dipped into this mixture. This process, termed "puddling," covers the roots with a coating which not only prevents their becoming dry in handling but insures a direct contact with the soil when they are planted in the field or garden. After removing the sets that are ready, the bed should be watered to settle the soil where it has become disturbed and then left for the younger plants to develop.

Packing for Shipment.—In preparing sweet potato plants for shipment or for sale, they are "drawn" from the bed and tied in bunches of 100 each with soft string. Sweet potato plants will not withstand excessive moisture and should always be packed while the tops are dry. A little damp moss or paper may be placed in the crate or basket and the roots bedded in it, but the tops should remain dry and have free ventilation. If the roots of sweet potato plants are carefully puddled without the mixture coming in contact with the tops, they will keep in good condition for a week or ten days.

Preparation of Land.—The character of soil devoted to sweet potato culture is generally quite easy to prepare. In preparing land for planting to sweet potatoes the plowing and fitting are practically the same as for corn. It should be borne in mind, however, that the work necessary for thorough preparation will be well repaid by the increased ease in handling the crop later. It is always desirable that a crop like sweet potatoes be grown as a part of the regular farm rotation. In the northern portion of the sweet-potato-growing area the crop will occupy the land the entire growing season, and a three or four year rotation should be practiced. Where the climate will permit, a crop of early snap beans, peas, or cabbage may precede the sweet potatoes, but in any case the land should not be planted to sweet potatoes oftener than once every three years. A good rotation is to devote the land to corn one year, sowing crimson clover in the alleys between the rows at the time the corn is given the last cultivation. During the following spring the crimson clover should be turned under and sweet potatoes planted; then in the autumn, after the potatoes are harvested, the land may be plowed, fitted and sown to rye or winter oats with plenty of grass seed. In this way a crop of grain

may be obtained during the time that the grass is becoming established. Allow the land to remain in grass one or two years and then repeat the rotation. Where corn is followed by sweet potatoes in the rotation, stable manure should be applied while fitting the land for the corn, and commercial fertilizers should be applied with the sweet potato crop.

The usual depth of plowing in preparing land for corn will prove satisfactory for sweet potatoes. The fact that sweet potatoes are not planted in the field until quite late in the spring makes it possible for the grower to select a time when conditions are favorable for the preparation of the land. Plowing may be deferred until the soil has become sufficiently dry to break up fine and mellow. It is important that the land should be harrowed within a few hours after plowing; further fitting may be deferred until later, and if the soil is inclined to be lumpy the work of pulverizing may best be done shortly after a shower and while the lumps are mellow. When the primary work of preparation is finished, the soil should be mellow to a depth of 6 or 7 inches and the surface smooth and even. Subsequent handling of the soil preparatory to planting will depend upon whether ridge or level culture is to be followed.

Preparation for Planting.—After plowing and fitting the land it is generally allowed to lie several days before being put in shape for planting. If level culture is to be practiced, the only thing necessary will be to run the harrow over the soil once and then mark in both directions at the desired distances for planting. The marking is generally done with either a one-horse plow, a flat-soled marker, or a disk marker. The disk marker is well adapted to this work, as it throws up a slight ridge which furnishes fresh earth in which to plant. Some growers who practice level culture mark the ground with a small one-horse plow and throw up a slight ridge upon which to plant; behind the plow a roller is used to compress this ridge to a low, flat elevation. Where the more universal ridge method of planting is employed the soil is thrown up by means of a turning plow or a disk machine. The ridges should be made at least one week before planting, in order that the soil may become settled and compact. The majority of sweet-potato growers make the ridges whenever the land is in good condition to work and then either roll or drag the tops just ahead of the planters.

Setting the Plants.—The success of the crop depends largely upon the way in which the plants start after being removed from the bed and set in the field or garden. Practical growers always plan to set the plants during a "season" or period when the conditions are suitable to a quick start into growth, either just before a rain or as soon afterward as the soil can be worked. The method of setting will depend entirely upon local conditions and the acreage to be grown, the essential features, however, being to get the roots in contact with moist earth and the soil firmly pressed about the plants. The use of water around the roots of the plants is desirable under most circumstances, as it not only moistens the soil but assists in settling it about the roots.

A large quantity of water is not necessary, one-half pint to each plant being generally considered sufficient.

Where level culture is practiced, the plants are set from 24 to 30 inches apart in each direction. On the eastern shore of Virginia the greater portion of the crop is planted 24 inches apart each way, requiring about 11,000 plants to an acre. By planting 30 inches apart each way, only about 7,000 plants are required to set one acre. Where the crop is grown on ridges it is customary to have the ridges from 36 to 42 inches apart from center to center and to place the plants 14 to 18 inches apart in the row. By this method an acre will require from 8,000 to 12,500 plants. An acre of good sweet potato land will readily support 9,000 to 11,000 plants, and the number most commonly planted by the several methods will fall within these figures.

Cultivation.—The methods of handling a crop of sweet potatoes do not differ materially from those employed with ordinary farm and garden crops. Within a few days after planting, a sweep or one-horse plow should be run in the alleys to break out the strip of earth left in ridging. The loose earth in the alleys should be worked toward the rows until a broad, flat ridge is formed upon which a small-tooth cultivator can be run quite close to the plants. After each rain or irrigation the soil should receive a shallow cultivation, and during dry weather frequent cultivations are necessary in order to retain moisture. About two hand hoeings are generally necessary in order to keep the rows free from weeds and the soil loose around the plants. As hand labor is expensive, it should be the aim to perform the greater part of the work by means of horse tools. Where sweet potatoes are planted in check rows and worked in both directions the hand work required will be reduced to a minimum, but a certain amount of hoeing is always necessary. When the vines begin to interfere with further cultivation the crop may be "laid by," i. e., given a final working in which the soil is drawn well up over the ridges and the vines then allowed to take full possession of the land. To do this it is often necessary to turn the vines first to one side of the row and then to the other by means of a stick or a wooden rake. After "laying by," very little attention is required until time for harvesting the crop.

Harvesting.—The harvesting and marketing of sweet potatoes direct from the field begins about the middle of August and continues until the crop is all disposed of or placed in storage for winter marketing. During the early part of the harvesting season the yield is light, but as a rule the prices paid are good. The supply for home use and those potatoes that are to be kept in storage should not be dug until just before frost. In the localities where frosts do not occur until quite late in the season the sweet potatoes ripen and the vines show a slight tinge of yellow when ready for handling.

Effect of Frost.—The foliage of the sweet potato is very tender and is easily injured by frost. A light frosting of the leaves will do no harm, but should the vines become frozen before digging they should be cut away to prevent the frozen sap passing down to the roots and injuring them. Where there is a heavy yield of potatoes the

soil is frequently cracked or the ends of the potatoes protrude above ground and are liable to injury from severe frost.

If on account of rainy weather or for any other cause the potatoes can not be dug before frost or immediately afterwards, the vines should be cut away and the potatoes removed at the first opportunity. If cold weather continues it may be necessary to draw a little extra soil over the hills to protect the potatoes, or the vines may be piled in a ridge over the row. A very slight frosting of the potatoes will cause them to decay within a short time after being placed in storage.

It is desirable that the soil should be comparatively dry at the time of harvesting sweet potatoes, and bright, drying weather is essential to the proper handling of the crop. Sweet potatoes differ from Irish potatoes in that they are not so easily injured by sunlight. However, they should not be exposed for any length of time if the sunshine is very warm. During the handling in the field it should be the purpose to remove all soil and surface moisture from the potatoes. Sweet potatoes should not lie exposed upon the surface of the ground during the night.

Grading and Packing.—In sorting sweet potatoes preparatory to packing, about four grades are recognized, as fancy, primes, seconds and culls. Those packed as fancy include only the most select, both in size and shape. The primes include all those adapted to general first-class trade, while the seconds include the smaller and more irregular stock which goes to a lower priced trade. The culls are not marketed unless good stock is exceedingly scarce, and as a rule are used for feeding to hogs. Sweet potatoes are usually shipped in barrels holding eleven pecks each. Some markets require that the barrels be faced and headed, while for others the tops are slightly rounded and covered with burlap. Small lots of extra-fancy sweet potatoes are sometimes shipped in one-bushel crates having raised tops; also in patent folding crates. Throughout the process of handling care must be exercised to see that the sweet potatoes do not become bruised, for upon this their shipping and keeping qualities greatly depend.

Storage.—Unlike most perishable products, the sweet potato requires warmth and a dry atmosphere while in storage. The method of storing will depend both upon the locality and the quantity of potatoes to be cared for. The temperature and conditions of a rather cool living room are admirably adapted for keeping sweet potatoes intended for home use in the North, while in the South they may be placed in pits or stored in outdoor cellars. The home supply may be placed in crates and stored in a loft over the kitchen part of the dwelling. Sweet potatoes should not be stored in bags or in barrels without ventilation.

The seed stock for planting the following year should be selected and stored separately in a small bin. As the potatoes are separated into their respective grades they are put into baskets and carried to the bins. Some growers prefer to do the grading in the field, but this necessitates the employment of a larger percentage of expert labor and delays the work of getting the potatoes hauled to the storehouse. Women and children can pick up the potatoes in the field, and two

or three experienced men can do the sorting and grading at the house in a much shorter time and in a more satisfactory manner.

Before starting to fill a bin, 2 or 3 inches of dry pine needles, straw, or chaff should be placed upon the floor. Beginning at the back of the bin the potatoes are piled to a depth of 30 or 40 inches until the entire floor space is covered and a number of slats are required to be placed across the doorway opening. A few grain bags filled with straw should be placed upon the potatoes at intervals from front to back of the bin, and upon these planks on which the men may walk while carrying in the next layer of potatoes may be laid. In this way a bin may be filled to a depth of 8 or 9 feet by about three layers. By dumping them in layers the potatoes have an opportunity to become thoroughly dry before a new layer is placed over them.

Temperature and Ventilation of Storage Houses.—Two or three days before beginning to bring in the potatoes, the storage house should be thoroughly cleaned and the heating appliance put in working order and started, in order to have the house both warm and dry when the crop comes in. Throughout the time of storing and for about ten days after the potatoes are all in the bins a temperature of 85° or 90° F. should be maintained in the house, with plenty of ventilation. This constitutes what is known as the sweating or curing process, and the keeping qualities of the potatoes depend upon the thoroughness with which this part of the work is done. Wood-burning stoves are frequently employed for heating sweet potato storage houses, but a hot-water boiler with coils of pipes along the walls of the building is very satisfactory.

After the crop is all in and thoroughly cured, the temperature of the storage house should be gradually lowered and may vary between 55° and 65° F., but considerable ventilation should be maintained. Sweet potatoes should be handled very carefully and as few times as possible, the essentials to good keeping being a reasonable degree of warmth, a dry atmosphere, and careful handling. Great care should be taken with the seed for the next year's planting to see that it is carefully handled and properly stored. While a temperature of 80° or 85° F. is required to properly start the seed into growth in the spring, a higher temperature during a long period of time in storage is liable to injure or even kill the buds. Potatoes intended for seed should not be stored in too great quantities, and where but a small supply is needed they can often be kept buried in dry sand after having first been thoroughly cured. The sand used for this purpose should be baked to insure the driving off of moisture, and may be placed around the potatoes while slightly warm. In controlling the ventilation of the storage house during the winter months, outside air should be admitted only when quite dry and when its temperature is lower than that of the air in the storage house. If warm, moist air is admitted considerable moisture will be deposited upon the potatoes, thus injuring their keeping qualities.

Loss from Shrinkage in Storage.—Under proper storage conditions sweet potatoes will shrink from 6 to 10 per cent, but the loss in

weight will be greater if the temperature of the house is carried too high. If the potatoes are not mature when dug from the field the loss from shrinkage may be as much as 15 per cent, and immature stock should be marketed early in the winter.

Marketing During Winter Months.—For marketing from outside pits it is desirable to have the quantity stored in one pit small enough to permit of all being removed at one time. The potatoes may be removed from outdoor cellars as desired. In marketing from heated storage houses the potatoes should not be disturbed until they are barreled or crated, and then they should be placed directly upon the market and sold without delay. When shipping during cold weather the barrels should at least be lined with paper, and a covering of heavy brown paper over the outside of the barrels will form a safeguard. If the potatoes are shipped in carload lots during the winter the cars should be either of the regular refrigerator type or felt lined.

Varieties.—Of the large number of varieties of the sweet potato there are not more than ten that are now of great commercial importance in the United States. For the markets that require a dry, mealy-fleshed potato those varieties belonging to the Jersey group are suitable. For the southern trade and where a moist-fleshed potato is desired those commonly designated as yams are in demand. Among the Jerseys that are extensively grown are the Big-Stem Jersey, the Yellow Jersey and the Red Jersey. The principal varieties of the yam group are the Southern Queen, the Pumpkin Yam, the Georgia, the Florida, and the Red Bermuda. Of the varieties mentioned there are a large number of special strains, known under many local names. In the selection of varieties for home use one must be governed largely by locality. As a rule those of the Jersey group will thrive farther north than those of the so-called yam types. For market purposes the particular variety or strain grown in the vicinity should first be selected, and afterward other varieties may be experimented with in a small way.—(F. B. 255, 295, 324; Tuskegee E. S. 2, 10, 17; Ariz. E. S. 86; N. Mex. E. S. 70; S. Car. E. S. 5, 136; S. Dak. E. S. 91.)

SWISS CHARD.

The part eaten is not the root, but the midrib of the leaf which is prepared much the same as asparagus. The flavor is distinct from that of the ordinary beet root. Give the same culture as required for beets. The soil should be richer. In the fall cover with straw. This will aid an early growth and help blanch the stems. This is a very valuable plant and should be cultivated more extensively.

THYME.

The leaves are used for seasoning, and a tea is also made therefrom for nervous headache.

TOMATOES.

Because of the tropical origin of the tomato it requires a long season for its growth and development, and on this account it is necessary in the Northern States, in order to secure paying crops, to resort to methods which lengthen the growing season. It is much easier for the gardener to accomplish this while the plant is small

than when it is large, and because early fruits are as a rule more valuable than late ones it is of advantage to the gardener to secure his crop as early in the season as practicable. The season is, therefore, lengthened at the beginning rather than at the end. This is accomplished by sowing seeds in hotbeds or greenhouses several weeks in advance of the time when they could be safely planted in the open.

The Tomato as a Field Crop at the North.—East of the Mississippi River and north of the latitude of Washington, D. C., the tomato is handled as an annual, the seeds being sown in hotbeds about the middle of March. The young plants, as soon as they have developed their first true leaves, are transplanted to stand about 2 inches apart each way and are allowed to develop in these quarters until they have attained a height of from 4 to 6 inches and the leaves begin to crowd considerably. They are then transplanted to pots, 3 or 4 inches in diameter.

Training Plants to Stakes.—For earliest returns it is desirable to train forced plants to a single stem by tying them to a stake 4 or 5 feet in height. These stakes should be driven firmly into the ground beside the plants and the plants carefully tied to them to prevent whipping and to keep the fruits off the ground. All side shoots should be kept pinched out and only the central leading stem allowed to develop to bring larger results. If the plants are to be trained in this way they can be set from 18 inches to 2 feet apart in the row, and about 3½ to 4 feet between the rows.

Training Plants on Frames.—Another plan sometimes followed in the training of tomatoes is to place a flaring frame, about 18 inches square at the base and 24 inches square at the top over the plants before they begin to spread. The shoots as they become heavy with fruit fall over against the sides of the rack and are prevented from coming in contact with the earth. For a kitchen garden where but few plants are grown this is a very satisfactory plan. The plants can be set somewhat closer than is the case where no supports are provided. For commercial plantations, however, the cost of the frames is prohibitive. The common commercial practice is to place the plants about 4 feet apart each way in check rows so as to allow them to be cultivated in both directions. Under intensive cultivation in a small garden, however, the first method, that of tying the vines to stakes, will be found very satisfactory.

Where tomatoes are grown on a large scale and where the product brings only a small price per bushel, expensive methods of handling and training can not be profitably followed. The common practice in growing tomatoes for the general market and for canning purposes in localities north of New York City is to sow the seed very thinly in a hotbed about March 15 and allow the plants to grow slowly without transplanting them until they can be put in the field about June 1. The plants, even with the most careful attention, when grown under these conditions will become long and thin stemmed, with a small tuft of leaves at the top.

Setting the Plants.—Plants more than a foot high which have been grown under these conditions should be treated somewhat as

WINFIELD RASPBERRY.

follows: Instead of attempting to set the plant deeply and maintain it in an upright position, remove all except three or four of the topmost leaves about the growing point. Dig a shallow trench along the row—a trench 3 or 4 inches deep—slightly sloping from a deep point at one end to the surface of the ground at the other. Place the bare stem of the tomato and the root in this trench, with the root in the deepest portion, cover the stem throughout its length with fresh soil, and pack this firmly. Under these conditions the plant will take root throughout the length of the buried stem, and in a short time the added root system which is thus given the plant will force it into vigorous growth. Plants of this character which are to be grown on an extensive scale are never trained. They are allowed to grow at will, and the fruits are gathered as they ripen without special attention to keep them off the ground or otherwise to care for them.

Length of Season.—The season of fruit production is longer in the higher than in the lower latitudes. This is a rather interesting and unexpected condition. Normally one would expect to find that the tomato would begin maturing its fruit earlier and would continue bearing longer in the latitude of the city of Washington than it would in the latitude of Boston; but this is not the case. Tomatoes in the latitude of Washington and south of this point come into bearing, quickly produce a heavy flush of fruit, and then refuse to do more, and in order to have a continuous supply throughout the season it is necessary for market gardeners and truckers to plant seeds in succession so as to keep up a continuous supply.

Fertilizers.—Since the tomato is grown exclusively for its fruit, those fertilizers which induce a large growth of plant and foliage are not desirable in the production of this crop. Soils vary greatly in regard to the quantity of available plant food they contain. The use of a fertilizer is determined largely by the character, mechanical condition, and composition of the soil. If a soil is deficient in all the essential elements of plant food—nitrogen, potash, and phosphoric acid—the application of any one or even two of them will not materially influence the yield of the crop. On the other hand, on soils deficient only in potash or phosphoric acid, or both, little would be gained by adding nitrogen, which is already in excess, to the other element or elements to be applied. Economy of operation, as well as the general effect upon the soil, must also be considered. This may be influenced by the character of the season, but should be based on the increased yield and increased net receipts of the crop.

As a general rule, readily soluble, "quick-acting" fertilizers which produce an early growth and early ripening of the crop are most desirable. Heavy dressings of stable manure tend to produce too much vine, and are seldom or never employed. If stable manure is used it is at a moderate rate, usually not more than one or two shovelfuls to a plant. This, if well decomposed and thoroughly incorporated with the soil, is very stimulating to the young plant and consequently very beneficial. Any fertilizer used should be applied, in part at least, at the time the plants are transplanted to the field.

Cultivation.—As soon as the young seedling plants from the hot-

bed or greenhouse are transferred to the field they should be given clean cultivation with implements which stir the surface of the soil but do not produce ridges or furrows. When the plants are set in check rows 4 feet apart each way it is possible in field culture to keep the plantation almost free from weeds by the use of horse hoes. If, however, the plants are set so that cultivation can be carried on only in one direction, hand hoeing will be necessary to keep down weeds between the plants in the row. Where land is not expensive, and where labor costs heavily, the cost of producing a crop of tomatoes can be decidedly lessened by planting in check rows and carrying on the cultivation by horsepower.

The grower should bear in mind, however, that the object of cultivation is not merely to kill weeds. The destruction of weeds is an important factor and in itself sufficient to justify clean culture, but the preservation of a soil mulch for the purpose of husbanding the moisture of the soil during periods of drought is of even greater value. With care in the choice of implements both results can be attained with the same expenditure of labor.

Harvesting and Marketing.—The fruits should be gathered two or three times a week if the tomato is grown as a truck crop. When used for canning purposes the harvesting periods need not be quite so close, and when the fruits are to be shipped some distance they should be gathered as soon as partially colored, instead of allowing them to become colored on the vine. The fruit of the tomato is velvet green up to the time the ripening process begins, and at this stage, if the products are to be shipped long distances, the fruits should be harvested. For home markets, however, the fruits should be allowed to ripen upon the plant.

In harvesting, none except sound fruits of a similar stage of maturity should be harvested and packed in any one receptacle. Leaky fruits and deformed fruits should be rejected. In packing tomatoes for the market, those that are symmetrical in form and uniform in size and of a like degree of ripeness should be selected for filling any one receptacle.

Varieties for the North.—There are a large number of sorts of tomatoes, each one possessing some points of merit or difference which distinguish it from all others. These differences enable the intelligent cultivator to select sorts for special purposes, as well as for special soils and climates. The varying demands of the markets and the different soil and climatic conditions presented in the various sections of the United States where the tomato is grown can only be satisfied by a variety list as variable as are the conditions.

Early ripening sorts are frequently irregular in shape, have comparatively thin walls, large seed cavities, and numerous seeds. The fruit is apt to color and ripen unevenly, remaining green around the stem, or to contain a hard green core. Later-ripening sorts, while not all superior to the others, have as a rule thicker and firmer walls, smaller seed cavities, and few seeds.

The most highly developed varieties now make few seeds and ripen evenly. These characteristics of the fruits are important fac-

tors in determining their fitness for special purposes. Medium-sized, smooth, spherical fruits, which ripen evenly and have small seed cavities and thick walls are especially suited to long-distance shipment. These qualities should enter into every sort selected to the greatest possible degree consistent with earliness, lateness, heavy yield, or any other special quality which gives the variety a marked commercial advantage. The following list is made up of varieties possessing some markedly distinct character, such as earliness, great size, purple, red, or yellow color, dwarf habit, etc.:

Early Ripening Varieties.—Sparks' Earliana, Atlantic Prize, Early Freedom.

Large-Fruited Varieties.—Ponderosa, Beefsteak.

Purple-Fruited Varieties.—Beauty, Acme, Imperial.

Red-Fruited Varieties.—Favorite (late), Honor Bright, Matchless, Stone, Royal Red, New Jersey.

Yellow-Fruited Varieties.—Golden Queen, Lemon Blush.

Dwarf or Tree Types.—Dwarf Champion, Station Upright Tree, Aristocrat.

Potato-Leaf Types.—Livingston's Potato-Leaf, Mikado, Turner's Hybrid.

The Tomato as a Field Crop at the South.—Commercial tomato growing in the Southern States is almost exclusively confined to the production of tomatoes at a season when they can not be grown at the North, except in greenhouses. On this account the commercial production of this crop is restricted to areas where there is very little, if any, freezing during the winter months.

Time of Planting.—At the extreme southern limit of the commercial cultivation of this crop in Florida the plants are grown so as to be ready for setting in the open about December 1. The date of seed sowing advances as the cultivation of the crop progresses northward, so that in northern Florida the seeds are sown early in January and the young plants placed in the field in March. Where frost conditions do not form barriers against the production of seedling plants in the open, the seed beds for the young plants are prepared in some sheltered situation where partial shade can be given and where the seed bed can be frequently watered. The young plants, as soon as they have attained the proper size—that is, from 6 to 10 inches in height—are transferred to the field in practically the same manner as are the hotbed-grown plants produced for general field culture at the North, and except for a specially early crop they are not transplanted or potted. The young seedlings in the cold frame will require careful attention in the way of watering and ventilation; otherwise many plants will be lost by damping off or from sun-scorching during bright days unless the sash are lifted or entirely removed.

Yield.—The yield of fruit in the South, under the conditions mentioned, is much less than it is in regions having the long growing periods characteristic of higher latitudes. Yields vary from 75 to 250 bushels to the acre, but the high price obtained for the fruits which are thus produced at a season when the sole competition

comes from the products of northern greenhouses renders the crop, when well handled, very remunerative.

Soil.—The soil which is preferred for the production of this crop is one which contains a comparatively high percentage of sand. In this region sandy loam or a sandy soil is preferred to bottom land for the cultivation of tomatoes. An area with a gentle slope to the south is considered more desirable than that with other exposure. If a wind-break can be secured along the north and west sides of the area very early crops can frequently be preserved through a wind-storm when the temperature, while not low enough to freeze the plants, will, when accompanied by a high wind, chill and destroy them.

Varieties for the South.—In the South, where the tomato is handled as a short-season crop, certain varieties are found to give best results in certain districts. Along the Atlantic seaboard the growers of tomatoes use such sorts as Beauty, Stone, Perfection, Aristocrat, and Paragon. In the truck regions of eastern Texas the Dwarf Champion is perhaps more universally grown than any other variety, but in this same region the Success is found to be a more profitable late-season or fall crop than the Champion.

Forcing Tomatoes.—In the forcing of plants, which means the growing of a plant out of its natural season and in an artificial environment, the first requirement for success is a properly constructed protective structure or greenhouse. Because of the tropical nature of the tomato more than ordinary provisions must be made in order to meet the demands of this crop. In the forcing of most vegetables a lower temperature and benches without bottom heat are satisfactory, but with the tomato the house must be piped so as to maintain a minimum temperature of 65 degrees F., and the benches should be so constructed as to admit of applying bottom heat.

Type of Greenhouse.—The type of house that is generally employed for the forcing of tomatoes is the even-span or a three-fourths span house. If the even-span house is used it is preferable to have the ridge running north and south; if the three-fourths span house is employed it is best to have the long side sloping toward the south. The tomato when grown in the forcing house, because of its long fruiting season and the fact that its clusters of fruit are borne one above the other, requires a considerable amount of head room. Low houses are therefore not desirable in the production of this crop. The side walls of a house designed for the forcing of tomatoes should be at least 4 feet in height, and the distance from the top of the middle bench to the ridge of the house should be at least 10 feet.

Soil.—The soil for the production of this crop should be well decomposed loam, made, if possible, from sods from an old pasture, the soil of which is a rather light clay loam or a heavy sandy loam. With this should be incorporated about one-fourth its bulk of well-rotted stable manure, preferably cow manure. By composting these two materials for from four to six months before they are required for use a very satisfactory soil for the forcing of tomatoes will result. Care should be exercised to allow the soil that is used for forcing

tomatoes to be frozen each year. The depth of soil required for the successful growth of tomatoes is considerably more than that employed for roses, although the temperature and other requirements are very similar to those demanded by the rose. While 4 or 5 inches of soil are adequate to produce a crop of roses, the soil for tomatoes should be at least 6 or 8 inches in depth; 8 inches is preferable. It is not well to allow the soil to remain in the greenhouse longer than a single season. It becomes somewhat exhausted and is likely to become infested with injurious forms of life, particularly nematodes, which cause root-knots upon the tomato plants, thus defeating the work of the gardener. This trouble, however, can be easily overcome by subjecting the soil to freezing.

Seedling Plants.—Two types of plants are used for forcing purposes—seedling plants and cutting plants. The former are, of course, seedlings grown from seed especially sown for the purpose of raising plants to be grown in a greenhouse. It is customary in the latitude of New York and northward to sow the seed for a forcing crop of tomatoes in the month of August. The young seedling plants, as soon as they develop the first true leaves, are then transplanted from the seed bed to small pots, preferably 3-inch pots. They are planted deeply at this time and are kept growing rapidly but not sufficiently to produce a soft, succulent growth. As soon as the 3-inch pots are filled with roots the plants are shifted to 4-inch pots, and when the plants have attained a height of 12 or 15 inches, and have developed their first blossoms, they are usually placed on the benches of the greenhouse, where they are to produce their crop. The plants are then set 15 or 18 inches apart each way in a soil prepared as previously described.

Cutting Plants.—Cuttings should be taken from strong, healthy, vigorous-growing plants in the field, and placed in the cutting bed about the last of August, where they will quickly take root. As soon as the roots have developed to a length of from one-half to 1 inch the young plants are shifted to 3 or 4 inch pots, where they are allowed to develop until the blossom buds are well formed or the blossoms have expanded, when they should be planted on the bench where they are to mature their crop, in like manner as noted for seedling plants.

Pollination.—In the field, where the tomato plants are exposed to the action of wind and to the visits of insects, no special attention is necessary in order to secure the pollination of the flowers and the setting of the fruits. Under the conditions existing in a greenhouse, however, it is necessary to artificially pollinate the flowers of the tomato; otherwise only a very small percentage of fruits will set and the object of the work will be defeated. It is therefore necessary to allow the temperature of the house to become quite high in the middle of the day on bright sunshiny days while the plants are in bloom, and to pass through the house at this time with a little stick, 18 inches or 2 feet in length, with which to strike the supporting strings or wires and thus to set the plants in motion and liberate the pollen and cause it to fertilize the flowers. A more satisfactory way, however,

is to use a watch glass, 1¼ or 1½ inches in diameter, embedded in putty, at the end of a handle composed of a light material, preferably white pine, which shall be 12 or 18 inches long. Grasp this spatula in the left hand and, with a light pine stick of equal length in the right hand, pass through the house, tapping each open flower lightly with the wand, at the same time holding the watch glass under the flowers to catch the pollen. Before removing the watch glass from this position lift it sufficiently to cause the stigma of the flower to dip into the pollen contained in the glass. By carefully going through the house from day to day during the blooming period nearly 90 per cent of the blossoms which develop can be caused to set. During dark, cloudy, stormy weather, however, a smaller percentage of plants will be fertilized than during bright, comparatively dry weather. The conditions in the greenhouse can not be modified so as to entirely overcome the adverse conditions existing on the outside, although with care much can be done in this direction.

Manuring.—It is desirable to keep plants of the tomato which are designed for forcing growing at a moderately rapid rate throughout the whole forcing period. Growth should be strong and robust at all times, yet slow enough to produce close-jointed plants which bear their fruit clusters at near intervals. There is considerable difference in varieties of tomatoes in this respect, and those which naturally bear their fruit clusters close together should be selected for forcing purposes. The manuring of the plants should, therefore, take a form which will be conducive to this strong, vigorous growth, yet not sufficiently heavy to produce plants which run to wood at the expense of fruit bearing.

Ventilating and Watering.—If careful attention is given to keeping the plants in a healthy condition by never allowing them to suffer from overwatering or from becoming too dry, and if sufficient ventilation is given without allowing draughts of cold air upon the plants, much can be done to prevent the development of mildew. If the plants are to be sprayed it should be done once a week or once in ten days, and then only in the mornings of bright days. Ordinarily, however, the atmosphere of the house should be kept dry rather than moist, as a very moist atmosphere is liable to produce a soft, succulent growth, which brings on a disease known to gardeners as œdema. This, however, can be prevented by care in keeping the house rather dry. The temperature of the house, too, should not be allowed to fluctuate through too wide a range. The night temperature for tomatoes should range between 65° and 68° F., while the day temperature should run from 70° to 80° F.

Varieties for Forcing.—The comparatively limited use of tomatoes for forcing purposes in this country has not resulted in the development of many sorts especially suited for this purpose. The Lorillard is the one American sort which is now almost exclusively confined to this use, and it is perhaps more generally cultivated in forcing houses than any other single variety.

The Tomato as a Field Crop for Canneries.—Owing to the fact that in canned tomatoes it is difficult for the average consumer to

note any deficiencies in the appearance of the original fruit, many labor under the delusion that any variety will answer for this purpose. This is a mistaken idea, as quality in canned goods is now an important factor, and it is quite as necessary that a good quality of product should be used for canning as for growing for the early or general market, although from the field side it is natural that tonnage should be a primary consideration.

In the matter of varieties, as in the case of early tomatoes, too much dependence should not be placed upon the name or upon the fact that a neighboring farmer secures good results from a given variety. There are so many variations in the character of soils, even in the same locality, which exert an influence upon the size and quality of crop that the best variety is usually one that is, in part at least, developed by the individual grower. The main point is to select varieties that produce large, smooth, solid fruits, which do not remain green or crack on the shaded side near the stem. Those which possess size as their chief characteristic are frequently of poor quality, as they are likely to possess large seed cavities and to ripen unevenly.

The conditions in some sections are such as to prevent the canners from making as much distinction between good and poor varieties as they would like. Canneries are in a measure obliged to receive all that come, unless they can control absolutely the land upon which the crop is grown. The variation in the quality of the crops of different farmers will make a difference of from 25 to 40 cans on a ton of fruit, or from 6 to 10 per cent—a very considerable item. In good seasons and with good fruit 400 cans may be regarded as the maximum number to be derived from a ton, though late in the season, and with poor varieties, as already stated, the pack from a ton is very much less. The interests of the grower and the canner are really identical in this regard. An improvement in the quality of the fruit will result in an improvement of the canned product and a consequent increase in the price of both the raw and manufactured products. Less expense is involved in growing suitable plants for cannery purposes than for other crops. This is due to the fact that earliness is not so important a factor as it is in the market garden crop.

Fertilizing and Cultivating the Soil.—In manuring and fertilizing, the character of the crop and the season of its growth should be remembered. Hence, recommendations that were made for an early crop do not apply in all cases except perhaps on the poorer classes of soils. In the first place, the plants are not put in the soil until summer, when the conditions are most favorable for the rapid change of organic forms of nitrogen into nitrates, and thus, if the soil has been manured or is naturally rich in vegetable matter, the additional application of nitrogen in immediately available forms is not so important. In the second place, the object of the growth is not early maturity, but the largest yield of mature fruit.

Setting and Cultivating the Plants.—The plants should be set from 4 to 4½ feet apart each way and cultivation should begin immediately. The first cultivation should be deep, in order to con-

serve the moisture, and each subsequent cultivation shallower, in order not to destroy the roots, which will fill the soil as soon as the plants reach maturity. The crop in good seasons should begin to ripen in August, and picking will continue from that time until the last of September.

Cost, Yield, and Value of Crop.—The cost of production per acre is much less for fruit for canning than in the case of early tomatoes, the chief difference being in the production of the plants. The several items may be classified as follows:

Cost of growing an acre of tomatoes for canning:

Plants	$ 2.00
Manures and fertilizers	8.00
Preparation of land, setting plants and cultivation	8.00
Picking and carting	10.00
Total	$28.00

The yield, as in the case of the early tomatoes, varies widely, ranging from 5 to as high as 20 tons per acre, even 30 tons per acre having been reported in exceptional cases, although the average for a series of years on average land will probably be under 8 tons. Where all conditions are carefully observed, 20-ton yields are frequently obtained, and at the prices received at the cannery, ranging from $5 to $7.50 per ton, according to the locality, the crop is a fairly good one and the net profits are quite as large as for other field crops.

TURNIPS.

A great variety of turnips is grown throughout temperate climates, some of which being coarse in texture are used as food for farm animals while other varieties are raised as table vegetables. There is considerable variation in the color, flavor, and composition of the turnip, the yellow-fleshed sorts as a group being commonly distinguished from the white by the name "Swedes" or "ruta-bagas." In the summer the early white varieties are usually preferred in spite of the fact that they are more watery, while in winter the yellow turnips are more commonly used.

The turnip requires a rich soil, and may be grown either as an early or a late crop. For an early crop, sow the seeds in drills 12 to 18 inches apart as early in the spring as the condition of the soil will permit. Two pounds of seed are required to plant an acre. After the plants appear, thin to about 3 inches. The roots will be ready for use before hot weather. For late turnips the seeds are usually sown broadcast on land from which some early crop has been removed, generally during July or August, but later in the South. Turnips are quite hardy and the roots need not be gathered until after several frosts. Turnips may be stored in a cellar or buried in a pit outside. Before storing, the tops should be removed.—(F. B. 255, 295; U. Id. E. S. 10; Mich. E. S. 20.)

VEGETABLE MARROW.

The so-called vegetable marrows are a valuable product and closely allied to the pumpkin, both as to species and habit of growth,

the principal difference being that the vegetable marrows are used while quite young and tender, and may be baked and served very much the same as sweet potatoes. The vegetable marrows should receive thorough cultivation in order that a tender product may be secured, and should be gathered while the outside skin is still so tender that it may easily be broken by the finger nail. The flesh is either boiled and mashed or baked in the oven and served with butter while hot.—(F. B. 255; Oreg. E. S. B. 74.)

Average Composition of Succulent Roots.

Kind of Vegetable	Refuse	Edible portion						
		Water	Protein	Fat	Carbohydrates		Ash	Fuel value per pound
					Sugar, starch, etc.	Crude fiber		
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories*
Beets, fresh	7.0	87.5	1.6	0.1	8.8	0.9	1.1	215
Beets, cooked	......	88.6	2.3	.1	7.4	....	1.6	185
Celeriac	20.0	84.1	1.5	.4	11.8	1.4	.8	285
Carrots, fresh	20.0	88.2	1.1	.4	8.2	1.1	1.0	210
Carrots, desiccated	......	3.5	7.7	.6	80.3	....	4.9	1,790
Parsnips	20.0	83.0	1.6	.5	11.0	2.5	1.4	300
Salsify "Oyster plant"	25.0	85.4	4.3	.3	6.8	2.0	1.2	250
Black salsify	20.0	80.4	1.0	.5	17.1	2.3	1.0	390
Radishes	......	91.8	1.3	.1	5.1	.7	.1	135
Turnips, white	10.0	89.6	1.3	.2	6.8	1.3	.8	160
Turnips, yellow (ruta-bagas)	10.0	88.9	1.3	.2	7.3	1.2	1.1	185
Kohl-rabi	20.0	91.1	2.0	.1	4.2	1.3	1.3	145
Onions	30.0	87.6	1.6	.3	9.1	.8	.6	225
Garlic	......	64.7	6.8	.1	27.9	.8	1.5	650
Potatoes	20.0	78.3	2.2	.1	18.0	.4	1.0	375

(Authorities consulted in the Chapter on Vegetable Garden.—Colo. Ag. Col. E. S.; U. Ill. A. E. S.; U. Idaho A. E.; Purdue U. A. E. S.; N. H. Col. A. E. S.; Mich. St. A. E. S.; Mass. Ag. Col. E. S.; Ohio Ag. E. S.; S. C. A. E. S.; Okla. A. E. S.; Texas A. E. S.; Va. A. E. S.; W. Va. U. A. E. S.; Cornell U. A. E. S.; R. I. Col. of Ag. and Mech. Arts E. S.; N. C. Col. of Ag. and Mech. Arts; N. Y. A. E. S.; U. Tenn. A. E. S.; Pa. St. Col. A. E. S.; Mich. St. Ag. Col. A. E. S.; S. Dak. A. E. S.; U. Wyo. E. S.; B. P. I.; Kans. St. Ag. Col. E. S.; N. J. A. E. S.; Tuskegee Normal & Industrial Inst. E. S.; S. S. E. S. Clemson Ag. Col.; N. Mex. Col. of Ag. and Mech. Arts E. S.; Fla. A. E. S.; Iowa Ag. Col. E. S.; U. Minn. A. E. S.; U. Nevada A. E. S.; N. Dak. E. S.; Oreg. A. E. S.; Del. Col. A. E. S.; Ark. Ag. Col. E. S.; U. Nebr. A. E. S.; Ga. E. S.; Md. A. E .S.; Miss. Ag. E. S. The entire article on Vegetable Garden was taken bodily from the best portions of the above bulletins, etc.)

Quantity of Seeds or Number of Plants Required for a Row 100 Feet in Length, with Distanses to Plant, Times for Planting, and Period Required for Production of Crop.

Brackets indicate that a late or second crop may be planted the same season.

Kind of vegetable.	Seeds or plants required for 100 feet of row.	Distance for plants to stand— Rows apart. Horse cultivation.	Distance for plants to stand— Rows apart. Hand cultivation.	Distance for plants to stand— Plants apart in rows.	Depth of planting.	Time of planting in open ground. South.	Time of planting in open ground. North.	Ready for use after planting.
Artichoke, Globe	½ ounce	3 to 4 ft.	2 to 3 ft.	2 to 3 ft.	1 to 2 in.	Spring	Early spring	15 months.
Artichoke, Jerusalem	2 qts. tubers.	3 to 4 ft.	1 to 2 ft.	1 to 2 ft.	2 to 3 in.	Spring	Early spring	6 to 8 months.
Asparagus, seed	1 ounce	30 to 36 in.	1 to 2 ft.	3 to 5 in.	1 to 2 in.	Autumn or early spring	Early spring	3 to 4 years.
Asparagus, plants	60 to 80 plants	3 to 5 ft.	12 to 24 in.	15 to 20 in.	3 to 5 in.	Autumn or early spring	Early spring	1 to 3 years.
Beans, bush	1 pint	30 to 36 in.	18 to 24 in.	5 or 8 to ft.	½ to 2 in.	February to April. [August to September.]	April to July	40 to 65 days.
Beans, pole	½ pint	3 to 4 ft.	3 to 4 ft.	3 to 4 ft.	1 to 2 in.	Late spring	May and June	50 to 80 days.
Beets	2 ounces	24 to 36 in.	12 to 18 in.	5 or 6 to ft.	1 to 2 in.	February to April. [August to September.]	April to August	60 to 80 days.
Brussels sprouts	¼ ounce	30 to 36 in.	24 to 30 in.	16 to 24 in.	½ in.	January to July	May and June	90 to 120 days.
Cabbage, early	¼ ounce	30 to 36 in.	24 to 30 in.	12 to 18 in.	½ in.	October to December	March and April. (Start in hotbed during February)	90 to 130 days.
Cabbage, late	¼ ounce	30 to 40 in.	24 to 36 in.	16 to 24 in.	½ in.	June and July	May and June	90 to 130 days.
Cardoon	½ ounce	3 ft.	2 ft.	12 to 18 in.	1 to 2 in.	Early spring	April and May	5 to 6 months.
Carrot	1 ounce	30 to 36 in.	18 to 24 in.	6 or 7 to ft.	½ in.	March and April. [September]	April to June	75 to 110 days.
Cauliflower	¼ ounce	30 to 36 in.	24 to 30 in.	14 to 18 in.	½ in.	January and February. [June]	April to June. (Start in hotbed during February or March)	100 to 130 days.
Celeriac	¼ ounce	30 to 36 in.	18 to 24 in.	4 or 5 to ft.	⅛ in.	Late spring	May and June. (Start in cold frame during April)	100 to 150 days.
Celery	¼ ounce	3 to 6 ft.	18 to 36 in.	4 to 8 in.	⅛ in.	August to October	May and June. (Start in hotbed or cold frame during March or April)	120 to 150 days.
Chervil	1 ounce	30 to 36 in.	18 to 24 in.	3 or 4 to ft.	1 in.	Autumn	Autumn	1 year.
Chicory	¼ ounce	30 to 36 in.	18 to 24 in.	4 or 5 to ft.	½ in.	March and April	May and June	5 to 6 months.
Citron	1 ounce	8 to 10 ft.	8 to 10 ft.	8 to 10 ft.	1 to 2 in.	March and April	May and June	100 to 130 days.
Collards	¼ ounce	30 to 36 in.	24 to 30 in.	14 to 18 in.	½ in.	May and June	Late spring	100 to 120 days.
Corn salad	2 ounces	30 in.	12 to 18 in.	5 or 6 to ft.	½ to 1 in.	January and February. [September and October]	March to September	60 days.
Corn, sweet	¼ pint	36 to 42 in.	30 to 36 in.	30 to 36 in.	1 to 2 in.	February to April	May to July	60 to 100 days.
Cress, upland	½ ounce	30 in.	12 to 18 in.	4 or 5 to ft.	½ to 1 in.	January and February. [Autumn]	March to May. [September]	30 to 40 days.
Cress, water	½ ounce	Broadcast			On surface	Early spring	April to September	60 to 70 days.
Cucumber	½ ounce	4 to 6 ft.	4 to 6 ft.	4 to 6 ft.	1 to 2 in.	February and March. [September]	April to July	60 to 80 days.
Dandelion	¼ ounce	30 in.	18 to 24 in.	8 to 12 in.	½ in.	Early spring or autumn	Early spring	6 to 12 months.

Eggplant	¼ ounce	30 to 36 in.	24 to 30 in.	18 to 24 in.	½ to 1 in.	February to April	April and May. (Start in hotbed during March)	100 to 140 days.
Endive	1 ounce	30 in.	18 in.	8 to 12 in.	½ to 1 in.	February to April	April. [July]	90 to 180 days.
Horse-radish	70 roots	30 to 40 in.	24 to 30 in.	14 to 20 in.	3 to 4 in.	Early spring	Early spring	1 to 2 years.
Kale, or borecole	¼ ounce	30 to 36 in.	18 to 24 in.	18 to 24 in.	½ in.	October to February	August and September. [March and April]	90 to 120 days.
Kohl-rabi	¼ ounce	30 to 36 in.	18 to 24 in.	4 to 8 in.	½ in.	September to March	March to May	60 to 80 days.
Leek	½ ounce	30 to 36 in.	14 to 20 in.	4 to 8 in.	1 in.	May to September	March to May	120 to 180 days.
Lettuce	½ ounce	30 in.	12 to 18 in.	4 to 6 in.	½ in.	September to March	March to September	60 to 90 days.
Melon, muskmelon	½ ounce	6 to 8 ft.	6 to 8 ft.	Hills 6 ft.	1 to 2 in.	February to April	April to June. (Start early plants in hotbed during March)	120 to 150 days.
Melon, watermelon	1 ounce	8 to 12 ft.	8 to 12 ft.	Hills 10 ft.	1 to 2 in.	March to May	May and June	100 to 120 days.
Mustard	¼ ounce	30 to 36 in.	12 to 18 in.	4 or 5 to ft.	¼ in.	Autumn or early spring	March to May. [September]	60 to 90 days.
New Zealand spinach	1 ounce	36 in.	24 to 36 in.	12 to 18 in.	1 to 2 in.	Early spring	Early spring	60 to 100 days.
Okra, or gumbo	2 ounces	4 to 5 ft.	3 to 4 ft.	24 to 30 in.	1 to 2 in.	February to April	May and June	90 to 140 days.
Onion, seed	1 ounce	24 to 36 in.	12 to 18 in.	4 or 5 to ft.	½ to 1 in.	October to March	April and May	130 to 150 days.
Onion, sets	1 qt. of sets	24 to 36 in.	12 to 18 in.	4 or 5 to ft.	1 to 2 in.	Early spring	Autumn and February to May	90 to 120 days.
Parsley	¼ ounce	24 to 36 in.	12 to 18 in.	3 to 6 in.	½ in.	September to May	September and early spring	90 to 120 days.
Parsnip	½ ounce	30 to 36 in.	18 to 24 in.	5 or 6 to ft.	½ to 1 in.	....	April and May	125 to 160 days.
Peas	1 to 2 pints	3 to 4 ft.	30 to 36 in.	15 to ft.	2 to 3 in.	September to April	March to June	40 to 80 days.
Pepper	⅛ ounce	30 to 36 in.	18 to 24 in.	15 to 18 in.	½ in.	Early spring	May and June. (Start early plants in hotbed during March)	100 to 140 days.
Physalis	⅛ ounce	30 to 36 in.	18 to 24 in.	18 to 24 in.	½ in.	March to May	May and June	130 to 160 days.
Potato, Irish	5 lbs. (or 9 bu. per acre)	30 to 36 in.	24 to 36 in.	14 to 18 in.	4 in.	January to April	March to June	80 to 140 days.
Potato, sweet	3 lbs. (or 75 slips)	3 to 5 ft.	3 to 5 ft.	14 in.	3 in.	April and May	May and June. (Start plants in hotbed during April)	140 to 160 days.
Pumpkin	½ ounce	8 to 12 ft.	8 to 12 ft.	Hills 8 to 12 ft.	1 to 2 in.	April and May	May to July	100 to 140 days.
Radish	1 ounce	24 to 36 in.	12 to 18 in.	8 to 12 to ft.	½ to 1 in.	September to April	March to September	20 to 40 days.
Rhubarb, seed	¼ ounce	36 in.	30 to 36 in.	6 to 8 in.	½ to 1 in.	....	Early spring	2 to 4 years.
Rhubarb, plants	33 plants	3 to 5 ft.	3 to 5 ft.	3 ft.	2 to 3 in.	....	Autumn or early spring	1 to 3 years.
Ruta-baga	¼ ounce	30 to 36 in.	18 to 24 in.	6 to 8 in.	½ to 1 in.	August and September	May and June	60 to 80 days.
Salsify	1 ounce	30 to 36 in.	18 to 24 in.	2 to 4 in.	½ to 1 in.	....	Early spring	120 to 180 days.
Spinach	1 ounce	30 to 36 in.	12 to 18 in.	7 or 8 to ft.	1 to 2 in.	September to February	September or very early spring	30 to 60 days.
Squash, bush	½ ounce	3 to 4 ft.	3 to 4 ft.	Hills 3 to 4 ft.	1 to 2 in.	Spring	April to June	60 to 80 days.
Squash, late	½ ounce	7 to 10 ft.	7 to 10 ft.	Hills 7 to 9 ft.	1 to 2 in.	Spring	April to June	120 to 160 days.
Tomato	⅛ ounce	3 to 5 ft.	3 to 4 ft.	3 ft.	½ to 1 in.	December to March	May and June. (Start early plants in hotbed during February and March)	100 to 140 days.
Turnip	½ ounce	24 to 36 in.	18 to 24 in.	6 or 7 to ft.	¼ to ½ in.	August to October	April. [July]	60 to 80 days.
Vegetable marrow	½ ounce	8 to 12 ft.	8 to 12 ft.	Hills 8 to 9 ft.	1 to 2 in.	Spring	April to June	110 to 140 days.

(F. B. 255.)

PART III

FIELD CROPS

IMPORTANCE OF GRAIN.

THE grain crop, as a factor in national economy, is one of vast importance, especially since it requires hundreds of millions to measure its financial rank. When its history for even fifty years is considered it is seen how far reaching is its influence. It is most substantial in supplying the needs of all classes of people, as it appears in a large variety of ways prepared for the table, and is prominent in giving quality and increased value to beef, mutton, and pork. In raising crops or animals, "well begun is half done." With grain are found among the necessities for good returns a productive soil well prepared, the best seed in reasonable amount, good judgment and prompt action in choosing a date for seeding, irrigation and harvest. Some varieties of grain possess superior merit in the line of milling qualities, in yield, in early ripening, in not shelling easily and in having straw that stands up. These same best varieties give better results—all points considered—by sowing the right amount of first class seed. The best filled kernels will produce the strongest plants.

The seed sown upon well prepared land is the beginning and fountain head of the crop which is to follow. Unless the seed is true to name, free from noxious impurities, and of at least average viability, the crop must fail to remunerate the sower. Although the seed is an all-important factor in the production of a crop, it is not the most expensive one. The cost of the seeding for most staple crops is inconsiderable compared with the cost of fertilizer, labor, and the yearly value of the land. Yet the failure of the seed means a more or less complete loss of the other items of expense.—(Nev. A. E. S. 27; N. C. A. E. S. 108.)

IMPROVING PLANTS BY SELECTION OR BREEDING.

For many years farmers have given careful attention to the methods of seeding, cultivation, manuring, and the like, but have generally neglected to give any careful attention to the methods of seed selection or breeding. They have universally recognized the importance of stockbreeding, and on all dairy and stock farms more or less careful attention has been given to the matter of breeding and improvement of the strain grown. To every farmer the field of breeding, whether in plants or animals, furnishes an interesting and profitable diversion. Plant-breeding especially, should become a farmer's fad. Few can afford to breed animals in the extensive way necessary to secure important results, owing to the

expense. No farmer, however, is so poor but that he can have his breeding patch of corn, wheat or potatoes. Indeed, if they but knew it, they can ill afford not to have such a breeding patch to furnish seed for their own planting.

If one is to use the most comprehensive methods of breeding, the operations become very complex and few farmers would have the time to undertake the work on so extensive a scale. No matter, however, what methods of breeding or seed selection the farmer is pursuing he should be familiar with the general principles involved.

The fact that we are able to improve plants by selection depends upon the occurrence of what are called variations. We are accustomed to think of plants as very stable and uniform. As we casually look over a field of Ox-eye daisies and admire their beauty, we distinguish no apparent variability; all seem to be alike. Nevertheless, if we examine the plants carefully and study the different individuals we find that each one possesses certain peculiarities. Some have large flower heads, others small flower heads; some have very many rays or petals, others comparatively few; some have broad rays, others narrow rays. Some plants are tall, others short. No two plants can be found which do not differ from each other in some noticeable character. They present different facial expressions, the same as do people or cattle, so that we may recognize different individuals apart after we have studied them and made their acquaintance. We know the Ox-eye daisy family, yet we are not accustomed to being introduced to Sam Ox-eye, Jim Ox-eye and John Ox-eye and attempting to recognize their characteristics so that we will know them when next they call. This, however, is one of the interesting studies which the breeder pursues. Careful gardeners learn to recognize the individual plants which they handle day after day the same as the shepherd recognizes the different members of his flock. These ordinarily slight variations which are spoken of commonly as individual variations are what the scientists now call continuous or fluctuating variations.

All of the individuals of any species, race or variety, whether wild or cultivated, show these individual variations. If we examine the different seedling trees in nursery rows of maple or oak, or different corn or wheat plants in fields of the same race, we will find them to present similar individual variations. In many cases such variations are transmitted by a plant to its progeny in the same manner that many of the individual characters or characteristics of a human being are in part at least transmitted to his progeny.

Such slight individual variations are the type of variation most used by animal-breeders in selecting to improve the breed. In plant-breeding such individual variations are also used when the breeder is selecting to produce an improved strain of any race. If, for example, the breeder desires to produce a heavy yielding strain of the Pride-of-the-North corn, he would select individuals having the maximum yield, plant these in an isolated place and continue the selection year after year, until a high yielding strain of the variety

has been produced. In such a selection the scientist would assume that there had been no change produced in the type of the race but that the breeder by the selection and isolation of the maximum yielding individuals had produced a family, within the race, of high yielding capacity, this being maintained continually by the selection. If, however, the selection and isolation of the highest yielding plants was discontinued and free intercrossing with inferior individuals was allowed, the mean yielding capacity of the race as a whole would soon be established again.

The keynote of improvement by selection is the choice of the very best individuals. The discovery of the best individual in any crop under cônsideration, requires the growing of a large number of individuals under as uniform conditions as possible, so that the experimenter may have opportunity to examine and select the best. Two methods of growing plants for selection are in general use which may be termed 1, the Nursery method, and 2, the Field method. The Nursery method consists in cultivating each plant under the most favorable conditions possible for its best development. By this method with wheat, for instance, Hallett pursued the policy of planting the individuals in squares a foot apart, which would give each plant abundant opportunity for stooling, and also the investigator an opportunity to clearly distinguish each individual plant and determine its characteristics, total yield, and the like. In recent years this method of growing the individual plants at a standard distance from each other in order to test their yielding capacities, and the like, has been used by Professor Hays in his experiments at the Minnesota Station. Here, however, a standard distance of four inches apart was used instead of one foot.

By the Field method the selections are made from plants grown under normal field conditions. The claim for this method is that we can only judge what a plant will do in the field under ordinary conditions of field culture, by growing and selecting it under these conditions. In the large majority of cases the first selections are probably made from plants grown in the field in the regular course of crop production, which thus were not specially grown for the purpose.

If one is to use the Nursery method, the plants must be especially planted. While the nursery method certainly allows the breeder to distinguish the individual plants more clearly, in crops like wheat, oats, and so on, which are sown broadcast or drilled, it entails very much extra work and is probably to be recommended only for the use of experimenters who are giving their entire time to the work.

In selecting the best plants in any crop the breeder must aim to examine a very large number of plants and carefully compare their important characters. To know what the important characters are, it is necessary to be familiar with the crop and have a thorough knowledge of those qualities which go to make up a plant of the greatest intrinsic value.

In making the first selections it is usually the best policy to

make a preliminary selection of a much larger number of plants than are actually desired. The breeder can then examine these selections with greater care and discard the poorest from among them, retaining only the superior individuals.

Careful breeders have found it very desirable to have a clearly defined ideal type which they are striving to produce. In selections within the race the breeder should have all of the characters of the race which he is breeding clearly in mind in order to adhere strictly to the type of the variety in the selections. In making selections of new variations, mutations, etc., in attempting to secure new races, naturally no one type can be adhered to. In testing these different individuals, however, the characters of a certain type should be borne in mind and deviations from this type in the progeny should be weeded out.

The unity of the individuals is also an important factor in plant-breeding. If, for instance, one is attempting to produce a seedless fruit, it is important that he discover a plant which shows a tendency to produce seedlessness throughout the entire individual. It would not be the correct policy for a breeder to select simply a single fruit which might accidentally be nearly seedless. He should examine a large number of fruits of different individual plants, and find a plant on which he can discover a general tendency toward seedlessness, showing in all of the fruits produced. By selecting seed from such individuals he may be able to find in time one such individual that will transmit to its progeny this tendency to produce few seeds.

A factor of primary importance in all breeding is the testing of what is termed the transmitting power. It is necessary for us to know that a certain plant, which for instance, gives a heavy yield, has the faculty of transmitting this tendency of producing heavy yield to its progeny. It is frequently found that two select plants which are equally good so far as their yield is concerned will give progeny which, as a whole, differ greatly in this respect. In the progeny of one, almost every plant may have inherited the quality, while in the progeny of the other only a few plants may show in any noticeable degree the inheritance of the quality. To determine this prepotency or transmitting power, it is necessary to carefully grade the progeny of each individual, and this is the primary reason for planting the progeny of different individuals in separate rows or separate plats, so that they may be easily examined. It would seem to be an easy matter when we plant the progeny of different plants in rows or small plats by themselves to get the comparative yield, for instance, of from 25 to 100 plants, and from this to figure up the average per cent of the transmitting power.

Control of Parentage.—In plant-breeding, as in animal-breeding, the isolation of the parents is a very important consideration. It is necessary that we should know the character of both parents wherever this is possible. In breeding plants, most attention is ordinarily given to the mother plant, and in very many instances the

characters of the father plant are entirely neglected. Animal-breeders, on the contrary, give more attention to the characters of the male parent, and a great deal of improvement in ordinary herds is accomplished by the introduction of improved blood through the male. In plant-breeding it is desirable that the seed of the select individuals be planted in a field by themselves. This insures that only progeny of carefully selected plants will be planted near together, and thus no ordinary stock will enter in as a contamination. One can be certain that each plant of the progeny is fertilized with pollen from another similarly good plant, or at least from a plant derived from good parentage. One difficulty, however, has been experienced by plant-breeders in the case of plants which normally cross-fertilize, in planting continuously their selected stock in such isolated plots. If this method is continued year after year, it results in fairly close inbreeding, which in the case of plants frequently results in a loss of vitality and vigor. In animal-breeding it is apparently the case that ordinarily with careful selection, there is no noticeable effect from close inbreeding, and many of the most famous animals have been produced as a result of the closest in-and-inbreeding. In plants, however, it is possible to secure much closer inbreeding than in the case of animals, as in many cases a plant can be fertilized with its own pollen.—(Cornell U. A. E. S. Bul. 41, 1908.)

Fanning Mill for Selecting Seed.—It has generally been assumed that the separation of the light-weight and small grains from seed wheat would result in an improvement of the crop grown, not only in quantity but in quality as well. An experiment was started in 1900 for the purpose of testing the value of the heaviest grains of seed wheat as separated by a wind blast, when compared with the lightest. Two varieties have been used, Turkish Red, a hard winter wheat, and Big Frame, a soft winter wheat. The machine used is so constructed that the wheat to be separated is delivered into an upward wind blast. The lighter seeds are carried over by the wind while the heavier fall against the blast into a receptacle below.

A lot of wheat was separated into two equal portions, and designated the Lighter Half and the Heavier Half. The Lighter Half was again separated, the lighter portion being known as the Lightest Light. The Heavier Half was also separated and the Heaviest Heavy secured.

The same method has been followed each year. The crop from the Lightest Light was separated into four parts according to weight, and only the lightest fourth retained and the crop from the Heaviest Heavy separated but only the heaviest fourth retained. To check results another lot of wheat has been sown continuously without separation. In the season of 1904 the wheat was so poor, due to a severe attack of wheat scab, that no separation was made, but the seed from each plat was simply cleaned and sown. Results are recorded in the following tables:

Kharkof Wheat Grown on Early Seed-Bed Preparation, New Agronomy Farm, 40 to 50 Bushels Per Acre, 1911, Dept. of Agr.

Yields per Acre for Light and Heavy Seed Wheat.

TURKISH RED WHEAT.

Kind of seed.	1900	1901	1902	1903	1904	1905	1906	1907	Av.
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Ordinary	27.5	26.0	17.8	31.8	14.3	20.5	63.0	51.0	31.5
Lightest light	23.0	26.7	24.6	30.0	15.6	23.2	62.5	51.0	32.1
Heaviest heavy	29.3	29.3	18.8	33.0	11.6	20.7	61.6	53.5	32.2

BIG FRAME WHEAT.

Kind of seed.	1900	1901	1902	1903	1904	1905	1906	1907	Av.
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Ordinary	25.8	25.8	11.5	27.3	12.5	20.5	54.6	50.0	28.5
Lightest light	20.5	21.2	8.0	25.8	12.3	19.7	50.5	50.0	26.0
Heaviest heavy	25.0	27.7	4.8	20.8	17.5	25.0	54.8	50.0	28.2

Weight per Bushel of Crop Harvested from Light and Heavy Seed for Five Years.

TURKISH RED WHEAT.

Kind of seed.	1902	1903	1904	1905	1906	1907	Average.
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu*	*Bu.*
Ordinary	57.0	......	44.0	62.0	61.0	60.0	56.8
Lightest light	60.0	......	42.5	62.0	61.0	61.0	57.3
Heaviest heavy	56.0	.....	44.5	61.0	61.0	60.0	56.5

BIG FRAME WHEAT.

Kind of seed.	1902	1903	1904	1905	1906	1907	Average.
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Ordinary	55.5	......	39.5	59.0	60.5	59.0	54.7
Lightest light	55.5	......	42.5	58.5	61.0	59.0	55.3
Heaviest heavy	52.5	......	46.5	60.0	61.5	59.0	55.9

The first two years of the experiments, the Lightest seed produced least, the ordinary was next in yield, and the heaviest yielded best. Since then, results have varied from year to year, and the average for the eight years does not show a marked advantage for either grade of seed.

The weight per bushel has been recorded in five different years, but no average difference has been noted. After eight years' continuous selection by the fanning mill, it was not possible by careful examination in 1907 to note a difference in either the quality or the quantity of the crops produced from the light and heavy seed.

Quite a little work has been carried on in both the United States and Canada bearing on this subject. At the Ontario Agricultural College, Guelph, Canada, where large seed has been compared with medium or with small seed in the case of the principal cereal, and root crops, the best results have uniformly been secured from the large seed, and the poorest results from the small seed. Also in the case of an experiment carried on for thirteen years in which the large, black seeds of Joanette oats have been compared with the small, light-colored seeds, the result has been very much in favor of the large, black seeds. The seeds for these experiments were all selected by hand, and not by fanning mill. The data do not show, however, the yield of the selected large seeds in comparison with the crop not so selected. In the United States a number of experiments conducted only one or two years have been reported where large or heavy seed was compared with small or light seed, with results slightly in favor of the heavier seed. However, where continuous selection has been carried on for more than two years the data do not indicate an advantage in favor of heavy or large seed. It should also be noted that in most of the experiments the comparison has been made of very heavy or very large seed with small or shrunken seed, rather than of the large seed with the original stock of seed, not so selected.

It is easy to conceive that differences might be obtained in the former case, particularly if wide extremes were selected, when no apparent difference might be found in the latter. To compare the selected seed with straight, unselected stock is the only practical test.

At the Ohio Station, experiments have been carried on for eleven years by continuous selection, in which three grades of seed were used, viz.: First grade, the large grains; second grade, the best grains passing through the sieve in screening out the first grade, third, unscreened wheat as it came fom the thrashing machine. The average yields for eleven years show no difference in yield or quality of grain. Three years' work with a greater difference in the quality of the different grades has given similar results. In summing up, Professor Williams makes the following statements:

Experiments extending over a series of thirteen years have failed to show on the average any gain from the use of seed from which the small and light grains have been removed by use of the fanning mill, although three seasons out of the thirteen the first grade gave largest yields.

North Dakota, after four years' hand selection and comparison

of large and small grains, concluded that the individual plants from large grains are larger than the individual plants from small grains, but made no comparison of yields under field conditions.

The Kansas Station, after four years' work with light, heavy, and unseparated seed, secured slightly increased yields in favor of the heavy wheat when the light and heavy were compared, but no difference when the ordinary unseparated stock was compared with the heavy.

At the Indiana Station, for four years, large seed gave an average yield of 1.47 bushels more than small seed. In order to obtain a census of opinion upon this very important question, a circular letter was addressed on December 31, 1906, to the various experiment stations in the central and western states, asking for an opinion on the following questions:

1. Have you any experience or reliable data which would prove conclusively that the continued use of the fanning mill to remove the shrunken and very light grains from wheat will tend to increase the crop?

2. After the light, shrunken and shriveled grains and foreign matter have been removed from the wheat, is there any evidence that further separation of the same according to the specific gravity of the grains, that is, into heavy and light seed, and this practice continued for a number of years, would affect one way or the other the yield of the crop?

Answers from eight were received and were uniformly to the effect that, except for the purpose of removing foreign matter and weed seeds, both of which would be troublesome in securing a uniform stand, or obnoxious weeds which might infect the land, there was no good evidence that the continuous use of the fanning mill would either improve the quality or increase the quantity of the yield.

The only rational method of improving the yielding power of our seed wheat seems to be through some system of plant selection, or by plant breeding, as it is now called. Experiments which have been in progress for years have shown a marked difference in the yield and quality of wheat from different plants.

The discussion in this bulletin refers to the *permanent* results which may be expected from the use of a fanning mill, and in no way discourages the use of a fanning mill or screen for removing obnoxious weed seed. Also where a large proportion of the seed grain is shrunken, immature or damaged, it will no doubt increase the following crop to remove the poor seed.—(U. Nebr. A. E. S. 104.)

SEPARATION OF SEED BY THE SPECIFIC GRAVITY METHOD.

The specific gravity method of seed separation consists in the immersion of the seed in liquids of varying density. These different densities are obtained by the addition of various quantities of salts or other agents by which the specific gravity of the liquid is increased or decreased, as desired. When different kinds of seeds are immersed in these solutions, those which are lower in specific gravity than the liquid in which they are placed will float on the surface. The

strength of the solutions must be varied for the different kinds of seeds to be treated. In the separation of barley, however, water can be successfully used.

A simple plan for separating seed barley by the specific gravity method has been successfully used by the Office of Grain Investigations. The apparatus used consists of two tubs or half barrels with a hole bored at the bottom of each and fitted with a pine plug. On the inside of the tub fine wire netting is tacked over the hole to prevent the loss of grain. Rope handles fitted in holes bored near the top facilitate handling. One tub is set above the other.

The method of procedure used in separating the grain is as follows: The upper tub is filled two-thirds full of water and the seed barley poured in, enough space being left to allow thorough stirring. The plump barley grains will sink to the bottom, while the light and shriveled barley and many of the oat and weed seeds will float on the surface when the grain is stirred. After stirring thoroughly, the grain that floats should be carefully skimmed off. When the skimming is completed, the plug should be pulled out and the water allowed to drain into the tub beneath. The grain should then be emptied from the upper tub upon a clean floor or a piece of canvas and spread out thinly to dry. The tubs can then be reversed and the operation repeated with another lot of grain. In order to dry the grain and prevent it from sprouting it should be stirred occasionally with a clean garden rake or shovel.

This selected seed should be sown as soon as it is sufficiently dry to run through the drill. As the seed will be somewhat swollen, the rate of seeding should be proportionally increased. Seed treated in this manner will be free from small and weak grains, and a better stand and greater yield will be secured from it than from ordinary seed.

This method is not to take the place of the fanning mill, but is to be used in connection with it. It will remove many of the small grains and weed seeds not removed by that machine. Where the fanning mill is not available the treatment here described will be found of great value.—(B. P. I. Cir. 62.)

THE TILLERING OF GRAINS.

Grains tiller or stool when they throw up shoots from the root after the seed has sprouted and the main stem has made its appearance. A stool of grain thus consists of the stems and shoots produced from a seed, and may be considered a single plant. This method of growth is characteristic of the grasses to which all cereal crops belong. The number of shoots which grow and develop into grain-bearing stems depends mainly upon the fertility of the soil, the influence of weather conditions, and the distance between plants. Worn-out soils, or soils in which the plant food is not readily available; cold weather, either too wet or too dry, and sowing the grain too thickly, are conditions which are detrimental to tillering. In considering the subject, it is taken for granted that the seed is of good quality.

The fertility of the soil and the spacing of the plants are fac-

tors which are under the control of the farmer, but the weather conditions vary with locality and season. In dry regions, where the important factor of soil moisture is unreliable, the tendency is not to rely very extensively upon the tillering process, but to sow greater quantities of seed per acre in order to obtain the required stand.

Comparatively little work has been done in this country on the tillering of grain, but extensive investigations of the amount of wheat, oats, and barley to be sown per acre have been made, and the effect of tillering may be inferred to some extent from the data obtained. However, direct investigations on the subject are few as compared with work on other phases of the culture of cereals. The Wyoming Station has published the result of investigations on the tillering of wheat, oats, and barley grown at five different places in the State, namely, Laramie, Lander, Wheatland, Sundance, and Sheridan. The results of this work are of interest not only in so far as they concern the tillering of cereals, but also inasmuch as they throw light on the growing of grains at high altitudes and in arid climates. The altitude of the different places where these experiments were made varied from 4,000 to 7,200 feet. In one case only were the plants grown without irrigation. The tillering experiments were conducted with a comparatively small number of plants, but in order to show what the results might be in actual field practice, a series of plat experiments with different amounts of seed per acre was made for the purpose of comparison.

In general, the results indicate that the number of mature heads produced by each seed varies greatly with the locality and the season, and that the number of heads and the amount of grain produced increase rapidly with the space given each seed. It was found that plants grown at wide distances apart produced shorter straw and a greater proportion of straw to grain than when thickly planted. The greater proportion of straw is considered to be due to the increase in the number of adventitious stems and the number and size of the leaves as each plant is accorded greater space within certain limits. It was noticed that, where too much room was given, many more stems were produced than would mature heads; and that, on account of the continuous growth from the crown of the stool during the summer, the grain matured late, did not fill well, and consequently was light in weight and of inferior quality. Larger heads were produced upon grain planted more than 1 inch apart, although they did not seem as uniform in size as the heads of plants grown at the smaller distance. The number of seeds in the largest heads produced was found to increase rapidly with the distance between plants. It is stated that more grain will be produced by each seed when planted at greater distances than 1 inch apart, but that the actual amount of grain will be less for the area of land used. "A study of our experiment seems to indicate that in farm practice sowing seeds so plants will be secured about 1 inch apart in the drill will produce the largest yields per acre of wheat or barley, but that oats should probably be planted a little thicker than this."

The author concludes from his investigations that, if 80 per cent

of the seed germinates and it is sown in drills 8 inches apart, it requires 78 pounds of wheat weighing 61 pounds per bushel, 86 pounds of barley weighing 53 pounds per bushel, and 61 pounds of oats weighing 40 pounds per bushel to seed an acre with plants 1 inch apart in the row.

At Laramie in 1897, 50 and 70 pounds of wheat per acre gave as large yields as greater amounts of seed, but where 100 pounds per acre were sown the grain weighed more per bushel and ripened earlier. There was little difference in the yield of barley plats sown at different rates per acre, but the plats with the heavier seeding ripened earlier and produced better grain. Oats seeded at the rate of 60 pounds per acre gave the best yield; thinly seeded plats failed to ripen the grain fully. At Sheridan in 1897 the best yields were obtained from sowing 50 to 70 pounds of wheat, 70 to 80 pounds of barley, and 80 to 100 pounds of oats per acre. The results obtained at the five different places indicate that barley has the greatest tillering power, followed by wheat and oats in the order mentioned, and that barley stands first in the yield of grain, oats second, and wheat third.

The results further showed that thick seeding of grain at high altitudes is an important factor in shortening the time required to mature the crop, and that upon like soils and under otherwise similar climatic conditions wheat, oats, and barley naturally produce less mature heads and less grain the higher the altitude at which they are grown.

The effects of irrigation were marked and beneficial. Grain under irrigation produced more mature heads per stool and gave a better yield of grain than that grown without nutrition.

The amount of grain produced from different amounts of seed per acre varies in different seasons. On account of increased tillering light seeding (from 30 to 50 pounds per acre) may produce as much grain as would a larger amount of seed, but when more seed is sown the difference in weight of grain per bushel along with a shorter period of maturity and evenness in ripening may more than pay for the extra seed used.—(F. B. 109.)

SHRINKAGE OF GRAINS.

The principal cause of the deterioration of corn during transit or in storage is an excessive amount of moisture. Corn as it is harvested in the autumn ordinarily contains from 20 per cent to 35 per cent of water, depending on the season and the relative time of harvesting.

The shrinkage that will take place in a crib of corn from the time it is cribbed in the fall until it is sold varies so greatly in accordance with the amount of moisture the corn contains when placed in the crib, and also the ventilation of the crib, that it is impossible to state a percentage of shrinkage that will apply with certainty to any particular crib of stored corn. Some carefully conducted tests in Illinois showed that during a period of twenty-one months the shrinkage was but 9 per cent of the original weight of the corn cribbed. Other tests show that during the first year the shrinkage in cribbed corn from

December to June varies from 8 to 18 per cent, with an average of 14½ per cent for the first year and an average of 20 per cent for two years.

For the ten years from 1896 to 1905 the Chicago price of corn for the month of May has averaged 3.8 cents per bushel, or 8.9 per cent, higher than the December price. As the average price in May is 3.8 cents higher than in December, a shrinkage of 8.58 per cent of the fall weight will equalize the increase in price, so that the same amount would be received whether the crop be sold in December or in May. Estimating interest on the value of the corn at 6 per cent, a shrinkage of 5.84 per cent will make it immaterial whether the selling be done in December or in May. In cases where 72 pounds are sold as a bushel in December and 70 pounds in May, estimating interest at 6 per cent, a shrinkage of 8.45 per cent will make it immaterial whether the selling be done in December or May.

In many local points there is a much greater difference between prices in December and in May than is shown by Chicago market prices. It will, of course, be necessary for each farmer to decide for himself whether it is more profitable to sell his crop at harvest time or hold it for higher prices. Corn that has not been kept dry during the winter is usually disposed of in early spring for the reason that it is likely to spoil upon the approach of warm weather. In general it is therefore better for the farmer who has cared for his corn crop well during the winter to hold it till summer or early fall, so that the price for his crop will not be governed by that paid for wet, low-grade corn thrust upon the market in early spring.

The Michigan Experiment Station reported as follows: In the fall of 1896, October 3 and 5, 6 loads of corn amounting to 16,767 pounds were placed in a crib. Most of it was hauled as soon as husked as the weather was damp and rainy. February 13 following the corn was again weighed. It had lost 5,725 pounds, a little over 30 per cent. This is an extreme case, as the corn was unusually damp when placed in the crib.

October 21, 1895, 3,310 pounds of ears were hauled from the field in a fairly dry condition on a damp day. The corn was left in the sacks until January 23, when it had lost 359 pounds or nearly 11 per cent.

An experimenter at Houghton Farm weighed corn from certain plots called north plots and west plots, October, 1881. There was a weight of 55,553 pounds taken from the north plots and 48,830 pounds from the west plots. The corn from both series was weighed again in March. The total shrinkage of ears from the north plots was found to be 7.41 per cent and from the west plots 7.49 per cent.

In the nineties owners of 6,000 acres in Christian County, Ill., erected in the center of the tract mentioned a double crib 26 feet wide, 250 feet long and ten feet high at the eaves, with a driveway 8 feet wide through the center and a good tight roof over all. Near one end of this crib a small office was built and a set of standard scales put in. Husking began October 22 and ended December 17. Every day while it was going on one owner remained at the office, and all

the corn that went into the crib was weighed and recorded. The quantity put in footed up 16,155 bushels of 70 pounds each. The corn was finally sold to be delivered early the following July. At that time the owner again took charge of the scales and weighed the corn as it came out of the crib. It was also weighed at the elevator, the total weight at the two places varying but a few pounds. The corn weighed 14,896 bushels and 40 pounds when taken out, showing a total shrinkage of 1,258 bushels, or a small fraction less than 7¾ per cent. When husking began the grain was considered to be in fair cribbing condition. Very little rain fell during the winter, only a few showers in March and April, while May and June were very dry.

In the fall of 1898 a series of experiments were begun at the Iowa Experiment Station to test the shrinkage of corn in the ear. There was weighed into a crib 13.5 feet long by 7.5 feet wide, built on a scale so that weights could be taken whenever desired, 7,000 pounds of corn in the ear. The corn was weighed from time to time and the shrinkage noted.

The loss for the first three months was 630 pounds, or 9 per cent; the second three months recorded a loss of 390 pounds, or over 5.5 per cent; the third three months gave a loss of 220 pounds, over 3 per cent; in the whole year the loss was 1,430 pounds, or slightly over 20 per cent.

The experiment was repeated the following year. The 7,000 pounds of corn shrank 400 pounds between October 19 and January 19; the loss for the entire year was 635 pounds, the lowest weight being on August 9. This was a shrinkage of 9 per cent. At the end of the year the kernels of corn contained 12.14 per cent of water and the cob 25.82 per cent.

On January 5, 1910, 500 bushels (28,000 pounds) of shelled corn having an average moisture content of 18.8 per cent were placed in the wooden hopper of a 30,000-pound scale in an elevator of the Baltimore & Ohio Railroad Co. at Baltimore, Md. The scale was tested prior to the beginning of the experiment, and after being filled with grain the hopper of the scale was covered with cloth to prevent an excessive quantity of dust from settling on the corn, and at the same time to permit a fairly free circulation of air over the top of the grain.

The corn used in this test was taken from the regular car receipts and was left in the hopper of the scale without handling from January 5 until May 14, a period of 129 days. It was then run out of the hopper and elevated three times to the same scale, the weight of the grain being taken after each elevation. After the third elevation the corn was held on the scale for an additional period of 18 days, or until June 1, at which time the experiment was terminated, making a total storage period of 147 days.

At the beginning of the test the average moisture content of the corn was 18.8 per cent. The average temperature of the corn and the temperature of the air was 20° F. The shrinkage in weight from January 5 to April 21, while the corn remained in good condition,

was approximately four-tenths of 1 per cent. The shrinkage in weight from April 21 to May 14 was approximately 2.6 per cent, during which time the corn went out of condition, becoming sour and hot, with a maximum temperature of 138° F. on May 2. The shrinkage during the three elevations on May 14 was 448 pounds, or 1.65 per cent, on the basis of the actual weight of corn in the hopper of the scale just previous to handling. The shrinkage during storage from May 14 to June 1, after the corn was cooled to 55° F. by handling, was 2.6 per cent. The total shrinkage during the test was 1,970 pounds, or slightly more than 7 per cent, while the natural shrinkage exclusive of the loss during the three elevations was 1,522 pounds, or approximately 5.6 per cent, calculated on the actual weight after making deductions for samples drawn for analyses. The rate of shrinkage while the corn remained in good condition was largely influenced by the weather conditions and by the relative humidity and temperature of the atmosphere.—(B. P. I. Cir. 81, 1911.)

Wheat fluctuates in weight according to the dryness of the air. The extent of this variation, under ordinary conditions, does not exceed six per cent, but where the grain is taken from an intensely dry climate to a comparatively damp one the gain may amount to twenty-five per cent.

In 1893, a firm of millers of North Lansing, Michigan, bought 1,500 bushels of wheat which was then in a hard, dry condition. It was hauled as soon as threshed and placed in the elevator. Ten days thereafter it was removed and found to have shrunk a little over thirty bushels. A loss of two per cent. Again, in 1896, 900 bushels placed in the same elevator while still slightly damp shrank thirty bushels in four months. A loss of three and one-third per cent.

An experiment was performed under the supervision of Professor Hilgard of the University of California to test the actual amount of gain or loss in weight in stored grain due to the fluctuations in the moisture content of the air. The results were as follows:

The dried grain was spread out in a very thin layer upon a small table, standing in shallow water and covered with a bell-jar. To make the air within this space as nearly saturated as possible, filter paper, dipping into the water below, extended near the grain, but not touching it. The whole was kept at a temperature of about 64.4 degrees F., and the grain was weighed from time to time in a corked flask to prevent loss during the weighing. Under such circumstances grain would continue to absorb moisture and increase in weight from twelve to eighteen days, the absorption being accompanied by an increase of bulk, which was not measured. The gain in weight from such absorption was as follows: In 18 days oats gained 19.8 per cent, barley 20.4 per cent, and in 14 days wheat gained 18.8 per cent. In all cases the increase was very rapid at first, then slower and slower, until about the 13th or 14th day, when a sudden increase occurred, due to the development of mold caused by the great amount of moisture present. Nearly half of the total increase occurred in the first twenty-four hours.

He also exposed air dry grain to an absolutely dry (artificially dried) atmosphere at the same temperature, and for the same period, 18 days. The loss was at first very rapid, then slower and slower, but continued in the whole period, amounting in 18 days to 9.3 per cent for oats, 7.8 per cent for barley, and 6.2 per cent for wheat.

According to these determinations, perfectly dry grain (artificially dried), exposed to a saturated atmosphere at a temperature of 64.4 degrees F. for 18 days, will increase in weight as follows: Wheat, 25 per cent; barley, 28.2 per cent; oats, 29.1 per cent. As the temperature of the interior of that state in summer is about 83 degrees F., experiments were made with dry grain at that temperature; and as the temperature increased, the amount of moisture thus lost in the given time also increased. Wheat dried in an artificially prepared atmosphere, believed to be about as dry as that which naturally occurs at harvest in the interior valleys of the state, led to the belief that the wheat cured there in the field at harvest time becomes nearly as dry as it would in an absolutely dry air, and, on transporting to a temperate climate may possibly increase 25 per cent, while a gain of 5 to 15 per cent may be looked for with almost absolute certainty. The profit of this grain in weight accrues to whoever owns the grain when the absorption is going on.

Oats when threshed, after passing through the sweating process in the stack, appear to shrink but little thereafter. At the Ohio Station in September, 1892, 4,243 pounds of recleaned oats were put up in ordinary grain sacks. There were fifty-four varieties in the lot, some of which were in small amounts so that not all of the sacks were full. These oats were kept all winter in a room artificially warmed, and in the following March were again weighed with a loss of only 29½ pounds, or less than 1 per cent.

At the Michigan Station 100 bushels of oats, 3,200 pounds, were weighed into a bin August 11, 1896, without recleaning and within an hour after threshing. They were in fairly dry condition, although they had been wet with rain while in the shock. On the 18th of March following they were weighed out and showed a total loss in weight of only seven pounds.

September 13, 1897, 806 pounds of International oats and 550 pounds of New Marine oats were weighed and placed in a bin in the sheep barn at the College farm. When removed the following March the International oats had shrunk but 13 pounds and the New Marine but 11 pounds.

On the 8th of October, 1899, 1,038 pounds of oats were weighed into a fairly tight bin in the Experiment Station barn, where they remained until the 10th of May, 1900, when they weighed but 1,003 pounds, showing a shrinkage of 3.4 per cent.—(F. B. 313; B. P. I. Bul. 99, Cir. 81; U. Ill. A. E. S. 113; Iowa Ag. Col. E. S. 45, 55; Mich. St. Ag. Col. E. S. 191.)

THE SULPHUR BLEACHING OF COMMERCIAL OATS AND BARLEY.

When a crop of oats or of barley is harvested under adverse weather conditions, or in a careless manner, there is generally a deterioration in both the quality and condition of the grain which

reduces its market value. In order to make grain thus damaged appear sound, healthy, and bright, and also to remove the objectionable odors which are usually present, such grain is often artificially bleached with sulphurous acid, thereby making it possible to realize a higher price from its sale.

The bleaching of grain, and especially the bleaching of oats, with sulphurous acid has been practiced in many of the larger grain markets for a considerable number of years, but with the comparatively recent developments in apparatus for bleaching grain rapidly and inexpensively the practice has become common also in the smaller grain centers. The process of bleaching is ordinarily referred to in the grain markets as "purifying," and grain so treated is sometimes sold as "purified" grain, no mention being made of its having been bleached or of sulphur having been used in the process of bleaching.

Based on investigations carried on at 13 grain markets in 3 of the leading oat-producing States, it is estimated that 18,732,000 bushels of oats and barley were bleached in those markets during the six months from October, 1908, to March, 1909, inclusive. The best data available show that during the same period approximately 75 per cent of the low-grade oats, ordinarily No. 4 White or below, received at those markets were sulphur bleached.

Laws have been enacted in several of the States under the authority of which the food commissions of those States have held it to be unlawful to offer sulphur-bleached or chemically treated grain for sale within those States except when it is so labeled.

The views of the Board of Food and Drug Inspection of the United States Department of Agriculture with respect to the use of sulphur dioxid in foods are as follows:

No objection will be made to foods which contain the ordinary quantities of sulphur dioxid if the fact that such foods have been so prepared is plainly stated upon the label of each package. An abnormal quantity of sulphur dioxid placed in food for the purpose of marketing an excessive moisture content will be regarded as fraudulent adulteration under the food and drugs act of June 30, 1906, and will be proceeded against accordingly.

In some States the laws and in other States the grade rules under which the grain-inspection departments work prohibit the grading of bleached or chemically treated oats and barley, but owing to the difficulty of distinguishing, except in extreme or exceptional cases, between the bleached and unbleached grain without submitting it to a chemical test, these prohibitions are not always carried out. When such grain is refused a grade it is designated as "purified" by the inspectors and sold by sample instead of by grade.

Selling bleached oats by sample has always been more or less unsatisfactory and has led to many disputes between buyer and seller. In marketing this class of grain, when it is not designated as "purified" it is customary to make up standard samples to which trade names are often given. These samples are sent to prospective buyers invariably in cloth sacks of open fiber which allow the sulphurous-

acid odor to be dissipated. Upon delivery of the grain on the basis of these samples, the odor of sulphurous acid is readily detected and the buyer is dissatisfied because he believes the car of grain delivered is not like the original sample.

Method of Sulphur Bleaching.—There are several types of grain bleachers in use, the most common of which is the "tower" or "chimney" bleacher, so called because of the style of its construction. The different forms of this type vary principally in the manner of distributing the grain at the top and in the way in which it passes through the bleacher. These tower bleachers are constructed of brick, masonry, or wood covered with galvanized iron; and for convenience in handling the grain through them the towers are built close to the elevator, the top of the tower ussally corresponding with the upper working floor of the elevator, which may be at a height of 25 to 60 feet above the ground. On the interior of the bleaching tower, which is about 3 or 4 feet square, are alternating series of deflecting shelves set at an angle of about 45° to the horizontal plane. The purpose of these shelves is to retard the movement of the grain and to distribute it evenly through the tower after it falls from the spout at the top.

As practiced commercially, sulphur is burned in a furnace or oven located some distance from the bleaching tower as a precaution against fire. The burning sulphur coming in contact with the oxygen of the air forms sulphur-dioxid gas, which is forced into the bleaching tower 8 or 10 feet from its base through a pipe leading from the furnace.

In order that the bleaching may be accomplished this sulphur-dioxid gas must come in contact with water and unite with it, in which case it forms sulphurous acid, which is the bleaching agent. For this reason the grain, as it passes into the bleaching tower at the top, is dampened with either a jet of steam or small sprays of water. The sulphur-dioxid gas, circulating upward, unites with the moisture adhering to the outside of the downward-moving grain, thereby making the bleaching possible.

The base of the tower bleacher forms a pocket in which the grain is allowed to accumulate to a point underneath the inlet for the sulphur dioxid. Owing to the accumulation of the grain in this pocket, better action of the sulphurous acid upon the stained and discolored grain is afforded by lengthening the time it is confined in the bleacher. With this method of bleaching, the grain is in the tower about two or three minutes.

After treatment in the bleaching tower the grain is returned to the elevator bins, where it is customarily left from 24 to 48 hours, and where a large part of the actual bleaching takes place. If one bleaching fails to produce the desired result, the process is repeated.

Before loading for shipment, the grain thus treated is "run" or "handled" in the elevator for the purpose of cooling it and also to remove the sulphurous-acid odor, which is only partly accomplished. More or less moisture is lost during the handling, but the operator aims to remove no more moisture than is necessary, because the addi-

tion of moisture is one of the sources of profit in the bleaching process.

Results of Bleaching.—Oats subjected to sulphur bleaching are the lower grades of white oats, the commercial grades of No. 3, No. 4, and "Sample" or "No grade" white oats usually being used. The reason that such oats receive low grades may be due to several causes, such as stain, field or mold damage, bad odors, or a low-test weight per measured bushel. When the damage is stain or mold the outward appearance of the grain is greatly changed by sulphur bleaching, and it is often difficult to distinguish between the sulphur-bleached grain and that which is naturally bright and sound, without subjecting it to a chemical test.

For the purpose of determining to what extent the outward appearance of oats is changed through sulphur bleaching, samples representing 9 lots of oats before and after bleaching were submitted to several experienced grain inspectors for grading in the regular manner, with the exception that they did not take into consideration the odor of sulphurous acid on the samples of bleached oats.

The results of this test were that 6 of the sulphur-bleached samples were classed the equivalent of a full grade higher than the samples representing the corresponding lots of oats before bleaching and 3 of the samples were raised from the average to the top of the same grade.

Change in Moisture and Weight.—Samples of oats before and after bleaching were collected at various places throughout the oat-producing sections. The samples before bleaching were taken as the grain was being elevated to the bleaching tower and the samples after bleaching were obtained as the grain was being conveyed back to the storehouse or elevator bin.

The moisture content of every sample was found to be higher after bleaching.

Moisture Content and Weight per Measured Bushel of Samples of Oats Before and After Bleaching.

Stage of Process.	Moisture content (per cent).				Weight per measured bushel (pounds).			
	Maximum.	Minimum.	Average	Average increase.	Maximum.	Minimum.	Average.	Average decrease
Before bleaching........	14	10	11.38	....	32	24.75	27.46	....
After bleaching..........	15.6	11.6	13.17	1.79	30.5	23	26.12	1.34

The average increase in moisture, due to the bleaching, without deducting the loss due to evaporation in handling between the bleacher, the elevator, and the car (0.50 of 1 per cent), was 1.79 per cent. The relative increase in moisture was not constant, the variations being due largely to different methods of operating the various bleachers as well as to the quality and condition of the grain before bleaching.

In this connection it must be borne in mind that within certain limits an increase in moisture content results in a decrease of the weight per measured bushel. In the samples used in these investigations the average decrease in weight per bushel was 1.34 pounds as compared with an average increase in moisture content of 1.79 per cent.

The average decrease in the weight per bushel due to the addition of moisture during the process of bleaching was 1.34 pounds; however, this decrease in weight per bushel was not sufficient to prevent the oats from being given a higher grade on account of the improvement in appearance after bleaching.

Odor Before and After Bleaching.—Commercial oats, as they reach the grain markets, vary greatly in quality, condition, and color. The odors range from a natural odor common to oats when harvested under favorable conditions down through a series of odors acquired from various weeds, the most common of which is the ragweed, and from different kinds of damage, such as "ground damage," mold, heat damage, etc.

The sulphur bleaching of oats changes these odors and generally removes or overcomes them entirely, leaving a strong sulphurous-acid odor when the oats are freshly bleached. The odor of sulphurous acid has a tendency to disappear, especially as the oats become drier. The absence of the odors commonly found in natural oats usually arouses suspicion that they have been bleached; therefore, in order to supply the desired odor and to make the detection of sulphur-bleached oats difficult or impossible by physical examination, it is a common practice to mix unbleached oats with bleached oats. The mixed grain is seldom questioned as having been bleached; nevertheless, a trace of sulphurous acid remains and may be detected by subjecting the grain to a simple, qualitative, chemical test.

Germination Reduced by Bleaching.—As bleached oats and barley are frequently selected for seeding purposes because of their exceptionally bright appearance, germination tests were made of both grains before and after bleaching in order to ascertain whether or not the vitality is affected by the bleaching process. The results of these tests are given in the following table:

Vitality of Oats and Barley Before and After Bleaching.

Kind of grain and laboratory No.	Final test, end of sixth day (per cent).		Kind of grain and laboratory No.	Final test, end of sixth day (per cent).		Kind of grain and laboratory No.	Final test, end of sixth day (per cent).	
	Before bleaching.	After bleaching.		Before bleaching.	After bleaching.		Before bleaching.	After bleaching.
Oats:			Oats—Con.			Barley:		
1........	92.5	89.5	21......	73.0	77.0	101......	84.5	83.0
2........	90.0	78.5	22......	79.0	67.0	102......	94.0	46.5
3........	90.5	82.5	23......	98.5	98.0	103......	97.5	97 5
4........	95.0	86.5	24......	88.5	73.0	104......	96.5	97.5
5........	90.0	81.0	25......	87.0	74.5	105......	97.5	94.5
6........	66.5	35.5	26......	84.5	82.5	106......	96.0	97.5
7........	90.5	69.0	27......	89.5	71.0	107......	78.5	67.0
8........	83.5	94.0	28......	99.0	80.5	108......	91.0	76.7
9........	92.5	90.0	29......	33.0	21.5	109......	91.5	94.0
10........	90.0	90.0	30......	93.5	73.0	110......	94.0	37.5
11........	75.0	96.5	31......	95.0	95.5	111......	90.0	90.5
12........	88.5	87.0	32......	95.0	53.5	112......	95.0	5.5
13........	85.5	0.	33......	89.0	40.0	113......	89.5	96.5
14........	92.5	9.0	34......	77.5	60.0	114......	94.0	97.0
15........	78.0	.25	35......	93.0	94.0	115......	94.0	5.0
16........	92.5	1.0	36......	99.5	87.5	116......	84.0	89.0
17........	83.5	86.0	37......	87.0	74.5			
18........	95.5	82.5						
19........	87.0	55.5						
20........	95.5	84.0	Average for oats..	86.92	68.14	Average for barley	91.72	73.45

It will be noted that an average of 86.92 per cent of the kernels of the unbleached oats germinated, whereas an average of only 68.14 per cent of the sulphur-bleached kernels germinated, being an average of 18.78 per cent less germination in the sulphur-bleached than in the unbleached oats.

With barley the percentage of germination was also found to be lowered by the treatment. The average germination of the unbleached barley was 91.72 per cent, while the average of the sulphur-bleached barley was only 73.45 per cent, being 18.27 per cent lower than the unbleached barley. In a few instances, it will be noted, the percentage of germination of the bleached grain was decidedly lower than the check, which is accounted for by the fact that these particular lots had been twice bleached, showing that the vitality of the grain is reduced in proportion to the severity of the treatment.

Feeding Experiment.—In these investigations no attempt was made to determine the effect of sulphur-bleached oats on the health of animals. However, for the purpose of ascertaining whether or not horses would eat sulphur-bleached oats as readily as unbleached oats, a feeding experiment was carried on at the Arlington Experiment Farm, near Washington, D. C., in co-operation with Prof. L. C. Corbett, Horticulturist in Charge, with two teams of farm horses and one team of carriage horses used by the Department of Agriculture.

The first part of the experiment extended through a period of 15 days and was confined to 2 teams of horses, which were being worked on the farm at the time, after which, for a 5-day period, the carriage team was fed. Sulphur-bleached and unbleached oats in

equal quantities were fed in separate boxes at the same time to each horse of the 3 teams. In order to exclude a possible error due to the convenience in the positions of the feed boxes, which were placed side by side, the bleached and unbleached oats were fed in different boxes on alternate days. It was observed that each horse ate the bleached oats as readily as the unbleached oats. Frequently the horses ate from the boxes alternately, so that they finished eating both the bleached and the unbleached oats at practically the same time.

Profits Resulting from Bleaching.—There are two sources through which a profit is derived by the process of bleaching oats. (1) By purchasing low grades of oats, improving their appearance, and selling them at approximately the price of unbleached oats of similar appearance, and (2) by increasing the original weight by the addition of moisture during the bleaching process.

The cost of bleaching grain with sulphur depends largely upon the facilities available for handling and the quantity of grain bleached. The average capacity of a bleacher is about 3,000 bushels per hour. The cost of the sulphur (20 to 30 pounds) required to bleach 1,000 bushels of grain should not exceed 50 cents. The steam required for the process is not an expensive item, as it is usually at hand for running other elevator machinery. From estimates obtained from various persons engaged in this line of work the cost of bleaching, when the plants are running full capacity, varies from about one-eighth to one-quarter of 1 cent per bushel.—(B. P. I. Cir. 74, 1911.)

THE BRABHAM AND GROIT COWPEAS.

[The Brabham cowpea (1) and its parents, Iron (2) and Whippoorwill Half-Crowder (3). The Groit cowpea (4) and its parents, New Era (5) and Whippoorwill (6). Small figures natural size; large figures magnified 5 diameters.]

(See pages [illegible] and [illegible].)

Legal Weights per Bushel of Seeds.

States and Territories.	Field Crops.																	
	Wheat.	Corn, shelled.	Corn in ear.	Corn in ear, unshucked.	Oats.	Barley.	Rye.	Buckwheat.	Beans.	Peas.	Cotton, Upland.	Cotton, Sea Island.	Pop corn, shelled.	Pop corn in ear.	Hemp.	Flax.	Rice, rough.	Peanuts.
Alabama	60	56	70	75	32	47	56	....	60	60	32	....	....	....	....	....	...	....
Arizona	60	54	....	...	32	45	56	....	{ff60 55	{..	....	....	....	....	....	....	...	....
Arkansas *a*	60	56	70	74	32	48	56	52	gg60	60	33⅓	....	....	....	....	56	...	....
California *b*	60	b52	....	...	b32	b50	b54	b40	......	....	....	....	....	....	....	....	...	....
Colorado *c*	60	56	70	...	32	48	56	c52	60	(c)	....	....	....	....	44	(c)	...	....
Connecticut	60	56	....	...	32	48	56	48	60	60	30	44	....	....	....	55	45	....
Delaware	60	56	....	...	....	....	....	....	......	....	....	....	....	....	....	....	...	....
District of Columbia *cc*	....	....	....	...	....	....	....	....	......	....	....	....	....	....	....	....	...	....
Florida	60	56	....	70	32	48	56	....	60	....	32	46	....	....	....	....	...	22
Georgia *d*	60	56	70	...	32	47	56	52	gg60	60	30	....	....	....	44	56	43	....
Idaho	60	56	....	...	36	48	56	42	......	....	....	....	....	....	....	56	...	....
Illinois *ef*	60	56	70	...	32	48	56	52	gg60	....	....	....	....	....	44	56	...	....
Indiana *g*	60	56	dd70	...	32	48	56	50	60	....	....	....	(g)	70	44	....	...	....
Indian Territory *cc*	....	....	....	...	....	....	....	....	......	....	....	....	....	....	....	....	...	....
Iowa	60	56	70	...	32	48	56	52	60	....	....	....	....	....	44	56	...	....
Kansas	60	56	70	...	32	48	56	50	60	....	....	....	56	....	44	56	...	....
Kentucky *h*	60	56	ee70	...	32	h47	56	56	gg60	60	....	....	....	....	44	56	...	....
Louisiana *i*	60	i56	(i)	...	32	i32	i32	(i)	(i)	(i)	....	....	....	....	(i)	(i)	...	....
Maine	60	56	....	...	32	48	....	48	62	60	....	....	....	....	....	....	...	....
Maryland *j*	(j)	(j)	(j)	...	j26	(j)	(j)	(j)	(j)	(j)	....	....	....	....	(j)	(j)	...	(j)
Massachusetts *k*	60	56	....	...	32	48	56	48	60	60	30	44	....	....	....	55	45	....
Michigan	60	56	70	...	32	48	56	48	60	60	....	....	....	....	44	56	...	...
Minnesota *lm*	l60	56	70	...	32	m48	56	50	60	60	....	....	....	....	50	(l)	...	....
Mississippi *n*	60	56	72	...	32	48	56	48	gg60	60	n32	....	....	....	44	56	...	....
Missouri *o*	60	56	70	...	32	48	56	52	60	60	33	....	....	....	44	56	...	(o)
Montana	60	56	70	...	32	48	56	52	60	60	....	....	....	....	44	56	...	....
Nebraska *p*	60	56	70	...	32	48	56	52	gg60	60	....	....	....	....	44	56	...	....
Nevada *cc*	....	....	....	...	....	....	....	....	......	....	....	....	....	....	....	....	...	....
New Hampshire	60	56	....	...	32	....	56	....	62	60	....	....	....	....	....	....	...	....
New Jersey	60	56	....	...	30	48	56	50	60	60	....	....	....	....	....	55	...	....
New Mexico *cc*	....	....	....	...	....	....	....	....	......	....	....	....	....	....	....	....	...	....
New York *qr*	60	56	....	...	32	48	56	48	60	60	30	44	....	....	....	r55	45	....
North Carolina	60	56	....	...	32	48	56	50	......	60	30	....	....	....	....	55	44	....
North Dakota	60	56	70	...	32	48	56	42	60	60	....	....	....	....	....	56	...	....
Ohio *stu*	60	56	68	...	32	48	56	50	60	u60	....	....	....	t42	44	56	...	(u)
Oklahoma	60	56	70	...	32	48	56	42	60	60	....	....	....	....	....	56	...	....
Oregon	60	56	....	...	32	46	56	42	......	....	....	....	....	....	....	....	...	....
Pennsylvania *v*	60	56	....	...	32	v47	56	48	......	....	....	....	....	....	....	....	...	....
Rhode Island	60	56	70	...	32	48	56	48	60	60	30	44	....	....	44	56	...	....
South Carolina *w*	...	....	....	...	....	....	....	....	......	....	30	w42	....	....	....	....	...	....
South Dakota	60	56	70	...	32	48	56	42	60	60	....	....	....	....	....	56	...	....
Tennessee	60	56	70	74	32	48	56	50	60	60	28	....	....	70	44	56	...	23
Texas *xy*	60	56	70	72	32	48	56	42	gg60	....	32	....	....	....	44	56	...	....
Utah *cc*	....	....	....	...	....	....	....	....	......	....	....	....	....	....	....	....	...	....
Vermont	60	56	....	...	32	48	56	48	62	60	....	....	....	....	....	....	...	....
Virginia *z*	60	56	70	...	z30	48	56	52	gg60	....	32	....	....	....	44	56	...	22
Washington *aa*	60	56	....	...	32	48	56	42	......	....	....	....	....	....	....	56	...	....
West Virginia	60	56	....	...	32	48	56	52	60	....	....	....	....	....	....	56	...	....
Wisconsin *bb*	60	56	(bb)	...	32	48	56	50	60	60	30	44	....	....	44	56	45	....
Wyoming *cc*	....	....	....	...	....	....	....	....	......	....	....	....	....	....	....	....	...	....

Legal Weights per Bushel of Seeds.—(Continued.)

States and Territories	Grass and Forage Plants													
	Clover	Timothy	Herd's grass	Hungarian grass	Millet	Japanese barnyard millet	Canary seed	Bluegrass	Redtop	Orchard grass	Amber cane	Sorghum	Kafir corn	Johnson grass
Alabama	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Arizona	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Arkansas *a*	60	60	...	...	50	...	...	14	14	14	...	50	...	28
California *b*	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Colorado *c*	60	45	...	(*c*)	(*c*)	...	...	14	(*c*)	(*c*)	(*c*)	...	(*c*)	(*c*)
Connecticut	60	45	45	...	...	...	...	...	...	...	...	...	...	...
Delaware	...	...	...	...	...	...	...	...	...	...	...	...	...	...
District of Columbia *cc*	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Florida	...	...	...	...	50	...	...	...	...	...	...	56	...	...
Georgia *d*	60	45	...	...	...	...	...	14	...	...	...	...	...	...
Idaho	60	...	...	...	...	...	...	...	...	...	...	...	...	...
Illinois *ef*	60	45	...	...	...	...	...	14	...	...	...	...	...	...
Indiana *g*	60	45	...	...	50	...	...	14	...	14	...	...	...	...
Indian Territory *cc*	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Iowa	60	45	...	50	50	...	...	14	...	...	...	30	...	...
Kansas	60	45	...	50	50	...	...	14	...	...	...	56	56	...
Kentucky *h*	60	45	...	50	50	...	...	14	...	14	...	...	...	...
Louisiana *i*	(*i*)	(*i*)	...	(*i*)	(*i*)	...	(*i*)	(*i*)	...	(*i*)	...	(*i*)	...	(*i*)
Maine	...	...	45	...	...	...	...	...	...	...	...	...	...	...
Maryland *j*	(*j*)	(*j*)	...	(*j*)	(*j*)	...	...	(*j*)	(*j*)	(*j*)	...	...	...	...
Massachusetts *k*	60	45	45	...	...	35	...	...	...	...	...	...	...	...
Michigan	60	45	...	50	50	...	...	14	14	14	...	...	...	...
Minnesota *lm*	60	45	...	48	48	...	...	14	14	14	...	57	...	...
Mississippi *n*	60	45	...	50	50	...	...	14	...	...	...	42	...	...
Missouri *o*	60	45	...	48	50	...	...	14	14	14	...	42	...	...
Montana	60	45	...	50	...	...	...	14	...	...	...	...	...	...
Nebraska *p*	60	45	...	50	50	...	...	14	...	...	...	*p*30	...	...
Nevada *cc*	...	...	...	...	...	...	...	...	...	...	...	...	...	...
New Hampshire	...	...	...	...	...	...	...	...	...	...	...	...	...	...
New Jersey	64	...	...	...	...	...	...	...	...	...	57	...	...	...
New Mexico *cc*	...	...	...	...	...	...	...	...	...	...	...	...	...	...
New York *qr*	60	45	45	...	...	...	...	(*r*)	(*r*)	(*r*)	...	...	...	...
North Carolina	60	...	...	...	...	...	...	...	...	...	...	...	...	...
North Dakota	60	42	...	...	50	...	...	...	...	...	...	...	...	...
Ohio *stu*	60	45	...	*s*50	*u*50	...	(*u*)	(*u*)	(*u*)	(*u*)	(*u*)	(*u*)	(*u*)	...
Oklahoma	60	42	...	...	...	...	...	...	...	...	...	...	...	...
Oregon	60	...	...	...	...	...	...	...	...	...	...	...	...	...
Pennsylvania *v*	60	...	...	...	...	...	...	...	...	...	...	...	...	...
Rhode Island	60	45	...	50	50	...	...	...	...	...	...	...	...	...
South Carolina *w*	...	...	...	...	...	...	...	...	...	...	...	...	...	...
South Dakota	60	42	...	...	...	...	...	...	...	...	...	...	...	...
Tennessee	60	45	...	48	*hh*50	...	60	14	14	14	...	50	...	...
Texas *xy*	60	45	...	48	50	...	...	...	...	...	...	...	...	...
Utah *cc*	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Vermont	60	45	45	...	...	...	...	...	...	...	...	...	...	...
Virginia *z*	60	45	...	48	50	...	...	14	12	14	...	...	...	...
Washington *aa*	60	...	...	...	...	...	...	...	...	...	...	...	...	...
West Virginia	60	45	...	...	...	...	...	...	...	...	...	...	...	...
Wisconsin *bb*	60	45	...	48	50	...	...	...	...	...	...	...	...	...
Wyoming *cc*	...	...	...	...	...	...	...	...	...	...	...	...	...	...

Legal Weights per Bushel of Seeds.—(Concluded.)

States and Territories.	Grass and Forage Plants								Miscellaneous								
	English bluegrass.	Italian rye-grass.	Velvet grass.	Rape.	Soy beans.	Cowpeas.	Velvet beans, in hull.	Beggarweed.	Broom corn.	Spelt.	Castor beans.	Osage orange.	Indian wheat.	Apple seed.	Chestnuts	Hickory Nuts.	Walnuts.
Alabama																	
Arizona																	
Arkansas *a*									48								
California *b*																	
Colorado *c*	(*c*)								(*c*)								
Connecticut																	
Delaware																	
District of Columbia *cc*																	
Florida							78	62			48						
Georgia *d*																	
Idaho																	
Illinois *ef*											46						
Indiana *g*											46	33					
Indian Territory *cc*																	
Iowa									30		46	32					
Kansas	22										46						
Kentucky *h*	14										45						
Louisiana *i*	(*i*)	(*i*)		(*i*)		(*i*)			(*i*)		(*i*)	(*i*)					
Maine																	
Maryland *j*																	
Massachussetts *k*					58												
Michigan											46	33					
Minnesota *lm*				50					57								
Mississippi *n*											46						
Missouri *o*											46	36				(*o*)	(*o*)
Montana																	
Nebraska *p*											46	32					
Nevada *cc*																	
New Hampshire																	
New Jersey																	
New Mexico *cc*																	
New York *qr*																	
North Carolina																	
North Dakota									30	48							
Ohio *stu*									(*u*)		(*u*)	(*u*)					
Oklahoma									30								
Oregon																	
Pennsylvania *v*																	
Rhode Island											46			40			
South Carolina *w*																	
South Dakota									30								
Tennessee		20	7						42		46	33		40	50	50	50
Texas *xy*																	
Utah *cc*																	
Vermont													46				
Virginia *z*						60						34			57		
Washington *aa*																	
West Virginia																	
Wisconsin *bb*				50													
Wyoming *cc*																	

a The Little Rock Board of Trade uses the legal weights per bushel for the State of Arkansas.

b The Merchants' Exchange of San Francisco uses the legal weight per bushel for the State of California for wheat. It also uses the following weights per bushel for the commodities named below:

	Pounds.
Barley:	
Brewing	46
Chevalier	53
Feed	41
Buckwheat	50
Corn, shelled	56
Oats:	
Black feed	30
Red feed	33
White feed	35
White milling	37
Rye	58

c The Denver Chamber of Commerce and Board of Trade uses the legal weights per bushel for the State of Colorado, except for buckwheat. It also uses the following weights per bushel for the commodities named below:

	Pounds.		Pounds.
Alfalfa	60	Meadow fescue (English bluegrass)	24
Amber cane	50	Millet	50
Broom corn	46	Orchard grass	14
Buckwheat	50	Peas	60
Flax	56	Redtop	14
Hungarian millet (Hungarian grass)	48	Redtop, fancy	32
Johnson grass	25	Sweet corn	50
Kafir corn	56		

d The Columbus Board of Trade uses the legal weights per bushel for the State of Georgia.

e The Chicago Board of Trade uses the legal weights per bushel for the State of Illinois.

f The Peoria Board of Trade uses the legal weights per bushel for the State of Illinois.

g The Indianapolis Board of Trade uses the legal weights per bushel for the State of Indiana. It also uses 56 pounds as the weight per bushel for shelled pop corn.

h The Louisville Board of Trade uses the legal weights per bushel for the State of Kentucky, except for barley, for which it uses the weight per bushel of 48 pounds.

i The New Orleans Board of Trade uses the legal weights per bushel for the State of Louisiana for wheat, shelled corn and oats. It also uses the following weights per bushel for the commodities named below:

	Pounds.		Pounds.
Alfalfa	60	Meadow oat-grass	14
Barley	48	Millet:	
Beans	60	German	50
Broom corn	46	Italian	50
Buckwheat	48	Mustard	58
Bur clover	8	Orchard grass	14
Canary seed	60	Osage orange	33
Castor beans	46	Peas, English:	
Clover:		Smooth	60
Alsike	60	Wrinkled	56
Crimson	60	Radish	50
Red	60	Rape	50
White	60	Rescue grass	14
Corn:		Rye	56
In ear	70	Rye-grass:	
Shelled, Adams	50	English	20
Cowpeas	60	Italian	20
Flax	56	Sorghum	50
Hemp	44	Sunflower, Russian	24
Hungarian grass	48	Teosinte	59
Japan clover	25	Timothy	45
Johnson grass	25	Turnip	58
Kentucky bluegrass	14	Vetch	60
Meadow fescue (English bluegrass)	15		

j The Baltimore Chamber of Commerce uses the following weights per bushel for the commodities named below:

	Pounds.		Pounds.
Barley	48	Oats	32
Beans	62	Oats (State)	26
Beans (State)	60	Orchard grass	14
Bluegrass	14	Peanuts:	
Buckwheat	48	African	32
Clover	60	Virginia	22
Corn:		Wilmington	28
On cob	70	Peas	60
Shelled	56	Peas (State)	56
Flax	56	Redtop:	
Hemp	44	Chaff	14
Hungarian grass	48	Fancy	32
Millet:		Rye	56
American	50	Timothy	45
German	50	Wheat	60

k The Boston Chamber of Commerce uses the legal weights per bushel for the State of Massachusetts.

l The Duluth Board of Trade uses the legal weights per bushel for the State of Minnesota. It also uses the following weights per bushel for the commodities named below:

	Pounds.		Pounds.
Flax	56	Macaroni (durum) wheat	60

m The Minneapolis Chamber of Commerce uses the legal weights per bushel for the State of Minnesota, except for barley, for which it uses the weight per bushel of 50 pounds.
n The Meridian Board of Trade uses 33 1/3 pounds as the weight per bushel for cotton seed.
o The Merchants' Exchange of St. Louis uses the legal weights per bushel for the State of Missouri and also uses the following weights per bushel for the commodities named below:

	Pounds.		Pounds.
Hickory nuts	50	Walnuts	50
Peanuts, dry southern	22		

p The Omaha Board of Trade uses the legal weights per bushel for the State of Nebraska, except for sorghum, for which it uses the weight per bushel of 50 pounds.
q The Buffalo Merchants' Exchange uses the legal weights per bushel for the State of New York.
r The New York Produce Exchange uses the legal weights per bushel for the State of New York, except for flax. It also uses the following weights per bushel for the commodities named below:

	Pounds.		Pounds.
Bluegrass	14	Orchard grass	14
Flax	56	Redtop	14

s The Cincinnati Chamber of Commerce and Merchants' Exchange uses the legal weights per bushel for the State of Ohio, except for Hungarian grass, for which it uses the weight per bushel of 48 pounds.
t The Cleveland Chamber of Commerce uses the legal weights per bushel for the State of Ohio, except for pop corn, in ear, for which it uses the weight per bushel of 40 pounds.
u The Columbus Board of Trade uses the legal weights per bushel for the State of Ohio. It also uses the following weights per bushel for the commodities named below.

	Pounds.		Pounds.
Bluegrass	14	Osage orange	33
Broom corn	46	Peanuts	24
Canary seed	60	Pearl millet	56
Cane	50	Peas, wrinkled	56
Castor beans	46	Redtop	14
Japan clover	20	Sorghum	50
Kafir corn	50	Sweet vernal grass	10
Meadow foxtail	25	Tall meadow oat-grass	12
Orchard grass	14	Wood meadow grass	14

v The Philadelphia Produce Exchange uses the legal weights per bushel for the State of Pennsylvania, except for barley, for which it uses the weight per bushel of 48 pounds.
w The Columbia Chamber of Commerce uses the weight per bushel of 45 pounds for Sea Island cotton seed.
x The Galveston Cotton Exchange uses the legal weights per bushel for the State of Texas.
y The Fort Worth Board of Trade uses the legal weights per bushel for the State of Texas.
z The Richmond Grain and Cotton Exchange uses the weight per bushel of 32 pounds for oats.
aa The Seattle Chamber of Commerce uses the legal weights per bushel for the State of Washington.
bb The Milwaukee Chamber of Commerce uses the legal weights per bushel for the State of Wisconsin. For corn, on cob, it also uses the weight per bushel of 75 pounds from harvest to January 1 and 70 pounds after January 1.
cc No legal weights.
dd "From harvest until December 1, 70 pounds; after December 1, 68 pounds."
ee "From November 1 to May 1, 70 pounds; from May 1 to November 1, 68 pounds."
ff "Small white beans, 60 pounds; other beans, 55 pounds."
gg "White beans."
hh "German, Tennessee, and Missouri millet."

Seedsmen's Customary Weights per Bushel of Seeds.

Kind of seed	Pounds per bushel
Alfalfa	60
Amber cane	45-60
Bent grass:	
Creeping	10-20
Rhode Island	10-15
Bermuda grass	24-36
Bird's-foot clover	60
Bitter vetch	60
Bluegrass:	
Canada	14-20
Kentucky	14-30
Texas	14
Broad bean	50-60
Brome, awnless	10-14
Broom corn	45-60
Bur clover:	
Hulled	60
Unhulled	8-10
Spotted	60
Castor bean	46-60
Clover:	
Alsike	60
Crimson	60
Egyptian	60
Mammoth	60
Red	60
White	60
Cowpea	56-60
Crested dog's-tail	14-30
Fescue:	
Hard	12-16
Meadow	14-24
Red	12-15
Sheep's	12-16
Tall	14-24
Various leaved	14-18
Flat pea	50-60
Flax	48-56
Hemp	40-60
Japan Clover:	
Hulled	60
Unhulled	18-25
Johnson grass	14-28
Kafir corn	50-60
Lentil	60
Lupine, white	50-60
Meadow foxtail	7-14
Meadow grass:	
Fowl	11-14
Rough-stalked	14-20
Meadow grass—continued.	
Wood	14-24
Millet:	
Barnyard	30-60
Broom corn	45-60
Common	48-50
German	48-50
Golden Wonder	48-50
Hungarian	48-50
Pearl	48-56
Milo maize	50-60
Oat-grass:	
Tall	10-14
Yellow	7-14
Orange cane	45-60
Orchard grass	10-18
Pea:	
Field	60
Garden, smooth	60
Garden, wrinkled	56
Peanut	20-30
Rape, winter	50-60
Redtop:	
Chaff	10-14
Fancy	25-40
Rescue grass	12-28
Rice	43-45
Rye-grass:	
English	10-30
Italian	14-25
Sainfoin	14-32
Serradella	28-36
Soy bean	58-60
Spelt	40-60
Sunflower	24-50
Sweet clover:	
Hulled	60
Unhulled	33
Sweet corn (according to variety)	36-56
Sweet vernal, perennial	6-15
Teosinte	40-60
Timothy	45
Velvet bean	60
Vetch:	
Hairy	50-60
Spring	60
Water grass, large	14
Wild rice	15-28
Yellow trefoil	60

CORN.*

Possibility of Doubling Present Yield.—It is possible within a few years to double the average production of corn per acre in the United States, and to accomplish it without any increase in work or expense. It is not to be understood from this statement that it is desirable to double the present corn crop, but that it is desirable to produce the same yield on a smaller number of acres and with less labor. If 60 bushels are raised on 1 acre instead of on 2 acres, the labor of plowing, harrowing, planting, cultivating, and harvesting is greatly reduced. The demand controls the quantity that should be grown. To meet demands the producers of the United States have, during the ten years previous to 1910, averaged in round numbers 2,500,000,000 bushels of corn yearly. In producing this quantity a little more than 95,000,000 acres have yearly been de-

* See also pages 213, 231, 449, 557 for illustrations.

voted to corn growing. The average production per acre has been 26 bushels. Very few farmers would like to acknowledge that their average production for the past ten years has been as low as 26 bushels per acre, but from the best estimates that have been made the conclusion is unavoidable that half of those who grow corn harvest less than 26 bushels per acre. Twice this quantity is a fair crop, three times 26 bushels is a good crop, and four times 26 bushels per acre are frequently produced.

Since the average crop in the States best adapted to corn growing is but little above the general average of the entire country, it is evident that the average is not lowered to any great extent by the poor crops in sections unsuited to corn growing. Moreover, the yield per acre in the New England States, with their poor soil and short growing season, is as great as in any other part of the country. This clearly indicates the possibility of greatly increasing the yield per acre in the corn belt. This is especially easy of accomplishment in the Southern States, where the present production per acre is low and where the growing season is not shortened by frosts.

Poor corn crops are usually attributed to unfavorable weather conditions, and frequently this is the true cause, for there are but few summers during which this crop does not suffer more or less at some stage in its growth. The most that can be done regarding the weather is to take the best possible advantage of the conditions as they exist. But there are other conditions that are responsible for low production—conditions that are directly under the control of the farmer—and it is these that make possible the doubling of the average yield per acre within a few years. Although entirely possible, it is not expected that the near future will witness an average production of 52 bushels for every acre grown. The failure to realize this production will result from the failure of many growers to improve their methods. That some growers in many different States are year by year producing 50 and 75 bushels of corn per acre proves the possibility.

The lines of improvement that will most easily and quickly double the present production per acre are as follows: (1) Improvement in the quality of seed planted; (2) improvement in the condition of the soil; (3) improvement in methods of cultivation.

Improvement in Quality of Seed Planted.—Until a community has its experienced and honest corn breeder, the best place for the farmer to obtain seed corn is from fields on his farm or in his neighborhood that were planted with a variety that has generally proved most successful in that locality.

Well-conducted corn breeding requires special methods that general farmers have not time to apply. (See Corn Breeding.) If there is in your locality a corn breeder who each year demonstrates the superiority of his corn, you should pay him well for his superior seed. Five dollars a bushel will be a profitable bargain for both parties. Such corn breeders are improving corn as cattle breeders have improved cattle.

The general farmer is a propagator rather than a breeder of

corn. He profits by the careful work of the breeder by adopting the higher yielding strains and propagating them.

What Constitutes Good Seed Corn.—By far too many consider seed good simply because it will grow. To be first class seed must be: (1) Well adapted to the seasonal and soil conditions where it is to be planted. (2) Grown on productive plants of a productive variety. (3) Well matured, and preserved from ripening time till planting time in a manner that will retain its full vigor.

How to Gather Seed Corn.—At corn-ripening time drop all other business and select an abundance of seed corn. The process is too important to be conducted incidentally while husking. When selecting seed corn give the process your entire attention. Get the very best that is to be had and preserve it well and your increased yields will return you more profit than any other work you can do on your farm.

The only proper way to select seed corn is from the stalks standing where they grew, as soon as ripe and before the first hard freeze.

As soon as the crop ripens, go through the field with seed-picking bags and husk the ears from the stalks that have produced the most corn without having any special advantages, such as space, moisture, or fertility. Avoid the large ears on stalks standing singly with an unusual amount of space around them. Preference should be given the plants that have produced most heavily in competition with a full stand of less productive plants.

An ear of cylindrical shape, well rounded at each end, affords the largest percentage of grain per cob as well as kernels of the most uniform shape. The cob should be neither too large nor too small, and should possess the property of drying well and quickly, causing it to be of light weight and of a bright, healthy color. The kernels should fit compactly together throughout their full length on both sides and edges, and should be uniform in shape and length on all portions of the ear.

Length is a very desirable character for the kernels of a corn to possess, as it is by increased length in proportion to the diameter of cob that the percentage of grain is increased. Soft, chaffy kernels, though long, or kernels with prolonged chaffy caps, are not desired. It is much better to select for increased length of kernel than to select for small cob. Selecting for small cob results in reducing the size of the ear, and it is also an easy matter to reduce the size of the cob to such an extent that the pressure of the kernels causes the ear to break.

The butt of an ear of corn should be well rounded out with deep, regular kernels, compactly and evenly arranged about a cup shaped cavity, the diameter of which should be about an inch. The diameter of the scar where the ear was attached to the stalk should be about three-fourths of an inch in medium sized varieties. If the butt is large and wide the ear will be hard to break off in husking; if it is too narrow the ear may blow off. The quality of the corn is strongly indicated by the character of the butts—clean, com-

pact butts meaning careful selection, and coarse, wide butts poor selection.

The tip of an ear should be well filled out to the end, and if possible completely covered with kernels. Too much attention should not be given to covered tips, however, as there are very few ears that have them and they are usually the shorter ears. It is better to have an ear of good size and length, properly proportioned and bearing deep kernels well out to the end than a short ear with a completely covered tip. Of course an ideal ear has completely covered tip combined with the proper size, shape and quality, but such ears are very rarely found.

Treatment of Seed Immediately After Gathering.—The same day seed corn is gathered the husked ears should be put in a dry place where there is free circulation of air, and placed in such a manner that the ears do not touch each other. This is the only safe procedure. Many farmers believe that their autumns are so dry that such care is superfluous. Seed corn in every locality gathered at ripening time will be benefited by drying as suggested. If left in the husk long after ripening it may sprout or mildew during warm, wet weather or become infested with weevils.

The vitality of seed is often reduced by leaving it in a sack or in a pile for even a day after gathering. During warm weather, with some moisture in the cobs and kernels, the ears heat or mildew in a remarkably short time. The best possible treatment immediately after gathering is shown on page 449. Ordinarily the best place to hang these strings of ears is in an open shed or loft. Permanent seed racks are more convenient than the use of binder twine, and when they are located in a dry, breezy place the ears dry successfully.

Only during unusually damp weather at seed-gathering time will fire be necessary. If heat is employed in a poorly ventilated room it will do the seed ears more injury than good. If used, the fire should be slow, long continued, and situated below the seed ears, with good ventilation above them.

Winter Storage.—After hanging in the shed or lying on the racks for two months, the seed ears should be "dry as a bone" and contain less than 10 per cent of moisture. They can remain where they dried or be stored in mouseproof barrels, boxes, or crates during the winter, but in either case must not be exposed to a damp atmosphere or they will absorb moisture and be injured. Some farmers place the thoroughly dried seed ears in the center of a wheat bin and fill the bin with loose, dry wheat.

Testing the Germination of Seed Corn.—Seed corn that matured normally and has been properly preserved will grow satisfactorily. It is very poor management to neglect proper preservation and to spend time in the spring separating by germinating tests those ears that have been badly damaged from those that have been slightly damaged. Prevention is better than cure, and in this case a cure is impossible.

Ears slightly damaged by poor preservation may germinate well, but will produce less than if they had received better care.

Experiments have shown that if a few kernels (preferably six) are taken from different parts of an ear of corn and all are found to germinate well—that is, to produce *good healthy sprouts* —practically all of the kernels on that ear will likewise show strong vitality. On the other hand, if a part or all of the kernels tested fail to germinate or show only weak sprouts, the proportion will be the same for all of the kernels on such ears. The testing of a hundred or more kernels from the entire lot of seed which has been shelled for planting does not meet the requirements, save, perhaps in a few very special cases.

The objection is frequently made that the benefits derived from individual-ear tests do not justify the amount of time and labor expended. This objection, however, is an invalid one and is never made by those who have carefully tested their seed in this way. When it is considered that 12 or 15 ears of corn will furnish enough seed to plant one acre, it can readily be seen that the time and labor required for the testing is extremely small.

The germination tests should be made five or six weeks before planting time, but even if it is necessary to take the plow from the field it is far more profitable to have a good stand of corn on 19 acres than it is to have a poor stand on 20 acres, thereby saving the time and labor necessary to prepare the ground and to plant and cultivate the additional acre. Yet many farmers are every year planting and cultivating 3 or 4 acres in every 20 for which they receive no returns.

Preparatory to the sampling of the individual ears for the germination tests, it is quite essential that those of desirable type be selected in order to avoid the testing of more ears than is absolutely necessary. This can be best done by arranging the ears on a table or on the floor, or in some such simple manner, so that they can be carefully compared. With the corn spread out in this way the best ears can be removed for seed and the undesirable ears discarded.

The number of kernels to be used for the germination test may be varied somewhat, but six kernels taken from different parts of the same ear give reliable results. The kernels from ear No. 1 should be placed in square No. 1 of the germinating box, the kernels from ear No. 2 in square No. 2, and so on. The kernels should be placed germ side up.

The kernels can be best removed with a dull pocket knife or similar instrument. Grasp the ear firmly in the left hand, pointing the butt of the ear away from the body. With the knife in the right hand the kernels can be easily removed by forcing the blade down along either the back or the side of the kernels. As the kernel is loosened, grasp it on the opposite side with the thumb and transfer it to the proper square in the germinating box. The first kernel should be taken about 2 inches from the butt of the ear. Give the ear a quarter turn either to the right or the left and remove the second kernel from the center of the ear. Make another quarter

turn and take the third kernel about 2 inches from the tip of the ear. Holding the ear in this same position, take kernel No. 4 about 2 inches from the butt of the ear. Make another quarter turn and take the fifth kernel from near the center of the ear. Make still another quarter turn and take the sixth kernel about 2 inches from the tip of the ear. The ear has now been turned completely around, two kernels have been taken from the butt, two from the center, and two from near the tip of the ear. If the work has been well done each set of two kernels was removed from exactly opposite sides of the ear.

At the beginning this work will undoubtedly seem laborious and some of the kernels will be injured, but with a little practice the kernels can be removed rapidly and in perfect condition. It must be remembered, however, that the side of the kernels containing the germ is toward the tip of the ear, and care must be taken that the germ is not injured during the sampling.

It is important that the ears be numbered or arranged in the same definite order as the corresponding tests in the germinating box. One of the most satisfactory methods for this purpose is the use of a rack. This is primarily a drying rack for seed corn, and is extremely simple in construction and likewise inexpensive. After the kernels from the first ear have been placed in square No. 1 of the germinating box, the ear is shoved on nail No. 1 of the drying rack, ear No. 2 on nail No. 2, and so on. These racks can then be suspended in some suitable place and there need be no fear of the ears being mixed while the germination test is in progress.

A germinating box can be made in a few minutes' time from any boards picked up about the cribs or other farm buildings. The box should be about 1½ or 2 inches deep inside and the length and width such as to suit the needs of the individual farmer, but it should not be made water-tight. Instead of filling the box with sand, soil, or sawdust, as is commonly recommended, the seed bed is made of heavy canton flannel or similar material, having two or three thicknesses of cloth in the bottom of the box and one or two thicknesses of cloth for covering the kernels after the squares have been filled. A new cloth should be thoroughly washed before using.

For use, first wet the cloth thoroughly by soaking in water and then place the half of the cloth, double thickness, which has been marked in squares, in the bottom of the germinating box. The kernels from ear No. 1 are then placed, germ side up, in square No. 1, and so on. When all of the squares have been filled, fold the other end of the cloth carefully over the kernels. If during the sampling the cloths have become dry, sprinkle them well with water. Cover the box with a piece of glass (oilcloth may be used) to prevent the evaporation of the water from the cloths, and set the box aside for a few days to await the results of the test.

The principal advantage of a germinating box of this kind is that it is almost impossible to injure the corn by the addition of too much water, as is frequently done where tests are made in soil or sand. Moreover, the entire development of each kernel, both root

and stem, can be observed and the sampling can be done in about one-half of the time required when sand or soil is used.

Where only a limited number of ears are to be tested a similar germinating apparatus may be made by using cloth between two dinner plates.

If the preliminary work has been well done the germinating box will need but little care until the sprouts are ready for counting.

The moisture necessary for germination is supplied from the wet cloths, and *in most cases the first wetting will be sufficient to complete the test.* However, if at any time the cloths become dry they should be moistened by sprinkling a little water over the top. If a piece of glass is used for the cover, as recommended, the amount of water condensed on the under side of the glass will usually show whether there is a lack of moisture.

Corn germinates best at a temperature alternating between 65° and 85° F., representing in a way what actually takes place in nature, the higher temperature prevailing from 4 to 6 hours during the day and the lower temperature at night. Temperatures such as are found near the stove or furnace in an ordinary country home approach these conditions quite well. It is important, however, that the temperature does not get too low during the night; a drop much below 55° F. will seriously affect the reliability of the test.

The kernels should begin to germinate freely about the third or fourth day, but the counting should not be done until the sixth or seventh day, or until most of the shoots or stems are from 1 to 1½ inches long. This part of the testing must be done with considerable care and requires good judgment, as kernels will be found in all stages of development. The thoroughness of the testing depends on proper selection at this time.

If the six kernels in any one square in the germinating box show six good healthy sprouts, the ear which they represent should be taken for seed. If one of the six kernels fails to germinate, or gives even a weak root or stem, the ear which it represents must be discarded as unfit for seed. There will also be cases in which all six kernels have germinated, but will be lacking in vigor. Under the most favorable conditions kernels of this kind might produce a good ear of corn, but as the chances are that they will never develop, or else will produce only a barren stalk or perhaps a nubbin, such ears should not be used for seed. It is thus only necessary to remember that all ears showing dead kernels or weak and poorly developed sprouts must be discarded and *only those used for seed in which every kernel tested has given a good healthy sprout.*

The ears which have shown a perfect germination are now ready to be butted and tipped and shelled for planting. In order to insure further uniformity in planting it is advisable to sort the ears before planting into two or three grades, according to the size of the kernels. This grading may be done by screening, if more convenient.

SCORE CARDS FOR USE IN SELECTING SEED CORN, AS ADOPTED BY THE OHIO CORN IMPROVEMENT ASSOCIATION, NOV. 1908, WITH EXPLANATORY NOTES:

FOR USE IN THE FINAL SELECTION OF SEED EARS.

1.	Adaptability	25
2.	Seed condition	15
3.	Shape of kernel	15
4.	Uniformity and trueness to type	15
5.	Weight of ear	10
6.	Length and proportion	10
7.	Color of grain and cob	5
8.	Butts and tips	5
		100

1. *Adaptability:* Of first consideration in the selection of seed corn. Indicated by the filling out of kernels, by ripeness and by the apparent utilization of soil and climatic conditions.

2. *Seed Condition:* Of vast importance, for seed corn that will not grow is worse than worthless. Indicated by solidity of ear and of kernels on the ear; by brightness of color, especially of germ, and by plumpness of tip. While the germination test is the final arbiter, the trained eye can determine much.

3. *Shape of Kernel:* Kernels should broaden gradually from tip to crown, with edges straight so that they touch the full length, and should be wedge-shaped without coming to a point. Observed from the edge they should have uniform thickness. Thin, shrunken or sharp-pointed kernels are very objectionable.

4. *Uniformity and Trueness to Type:* The ears selected should be uniform in size, shape, color, indentation and size of kernel. Uniformity, or trueness to the type determined upon, is essential to progress in corn improvement. Uniformity of kernels is essential to machine planting.

5. *Weight of Ear:* To be determined by the use of scales after corn is thoroughly air dry. Many seasons this is not practical before January. Where the stand and other conditions of growth are equal, weight of ear is a good indication of productiveness.

6. *Length and Proportion:* Length will vary according to environment. No standard can be set by the score card save that set by maturity and proportion. Circumference is measured at one-third the distance from butt to tip. It should not exceed four-fifths nor fall below three-fourths the length.

7. *Color of Grain and Cob:* Grain should be free from mixture. Uncertain tints in cob and grain, and off-colored kernels are evidences of mixing. White corn should have white cobs, and yellow corn should have red cobs.

8. *Butts and Tips:* Kernels should extend in regular rows over the butt and against the shank. The shank, however, should have sufficient size to support the ear. Swelled, open or badly compressed butts, as well as those having kernels of irregular size, are objectionable.

The tips should have kernels of even size, well dented and preferably in regular rows. An under-sized ear is more objectionable with a completely capped tip than with a little bare cob. A sharply tapering tip is not desirable.

FOR USE IN THE PLANT SELECTION OF SEED CORN.

1. Adaptability	35
2. Vigor	25
3. Height of plant, and height and angle of ear	15
4. Uniformity and trueness to type	10
5. Weight of ear (estimated)	15
	100

EXPLANATORY NOTES.

1. *Adaptability:* Plants must be adapted to the average soil and seasonal conditions prevailing in the locality. Corn that is too late or too early in maturing, or that shows a lack of adaptability to soil conditions, should be cut accordingly.

2. *Vigor:* Indications of vigor are seen in uprightness of stalk; in a well developed stalk, leaf and ear; in freedom from disease. In marking for vigor note carefully the conditions of growth.

3. *Height of Plant and Ear:* Avoid extremes in either direction, in the case of both plant and ear. The market condition of an ear is favored if tip points downward.

4. *Uniformity:* Uniformity of plant and ear in manner of growth, height of plant and ear, etc., and conformity to the type determined upon.

5. *Weight of Ear:* While it can only be estimated at the time selections are made, yet even then it is an important point to take into consideration in selecting for high yield, if the conditions of growth are noted.

FOR USE IN JUDGING VARIETIES OF CORN AT HUSKING TIME.

1. Bushels per acre (Uniform moisture test)	50
2. Maturity	25
3. Uniformity and trueness to type	15
4. Color	10
	100

EXPLANATORY NOTES.

1. *Bushels per Acre:* That which we grow corn for. Theories must give place to facts.

If impracticable to shell all of the corn, a dozen average ears of each variety may be shelled, the per cent of grain determined and the total yield of grain computed therefrom.

All yields to be reduced to a uniform moisture content.

2. *Maturity:* To be determined by the actual condition of corn.

3. *Uniformity:* Uniform as to size, shape and type of ears, and marketability.

4. *Color:* An indication of purity and market quality.

IMPROVEMENT IN CONDITION OF SOIL.

The opportunity for the improvement of the soil offers a wide and inviting field of effort to the intelligent and progressive farmer. While the methods to be adopted vary with the character and condition of the soil, the climatic condition, and the use that is to be made of the land, the general principles involved are here presented in the hope that they may prove helpful to farmers in all sections where corn is grown.

While it is true that proper attention to seed selection and methods of cultivation will greatly increase the average production per acre for all land now devoted to corn growing, it is equally true that the cultivation of corn will never be found profitable on very poor land. Some growers, from force of habit, perhaps, every spring plant corn on land which they know is too poor to produce a profitable crop.

While this practice continues, the soil as well as the farmer will remain poor. The plowing and cultivating of poor soil is as expensive as the plowing and cultivating of fertile soil. The man who cultivates poor soil and harvests poor crops can not profitably compete with his neighbor who grows good crops with but little, if any, greater expenditure of labor or capital. Corn growing should not be attempted on poor land until it is brought into a fertile condition by the growing and plowing under of leguminous crops, the application of manure, etc. In the meantime some crops that require less fertility than corn may be grown. It should be remembered that the nature of the corn plant is such that it will not produce grain unless the soil is rich enough to afford a considerable growth of stalk, and that, in general, the richer the soil the heavier will be the yield of grain. For this reason some other plants will produce fair crops on soil too poor to produce corn. A cotton plant adjusts its yield of lint to the fertility of the soil, a small plant producing a small number of bolls containing lint of as good a quality as that from a larger plant bearing many more bolls. A hay crop is also in quite regular proportion to the fertility of the soil. This is not true, however, of corn. When poor soil dwarfs grass to half its normal size, the crop of hay is reduced by about one-half, but when poor soil dwarfs the corn plants to half their normal size it is probable that there will be no grain yield, or if any ears are produced they will be small and inferior.

Even in the best corn-producing States there is some land so poorly cared for that farmers who persist in attempts to grow corn on it receive but little for their labor. Such land, however, in a few years' time can be made to produce good corn crops. The growers who are quickest to learn the futility of attempting to grow corn on impoverished land are those whose farms contain some poor upland fields and some fertile bottom land. They find it necessary to fertilize and renovate the poor fields or confine corn growing to the bottoms. In most regions creek bottoms and river valleys are particularly adapted to corn growing, as they usually have a fertile soil and a subsoil well supplied with moisture.

Another explanation of the low yield per acre on many farms

is the amount of unsuited or unimproved areas frequently embraced within the boundaries of fields planted to corn. In many cornfields throughout the country may be seen portions or spots on which it is impossible for corn to thrive. These may be clayey spots, or swampy or undrained areas, or ground adjacent to timber. It is too great a waste of labor to plow, harrow, and cultivate such unproductive spots. They should be improved so that they will yield a profit, or they should not be planted at all. The poor clay spots should be enriched, the swampy places drained or filled, and the corn should be planted farther from the timber, with a strip of timber grass next to the trees. Many farms could be made more profitable by rearranging the fields in order to make them more uniform as regards moisture and soil fertility, so that the entire field may be treated as the character of the soil may demand. No field can be well tended if the corn rows extend through a portion too wet for cultivation when another portion is in best condition for cultivation.

Soil Washing and Its Prevention.—More land has been rendered unfit for corn growing by the washing away of the surface soil than by constant cropping. Soil washing must be guarded against if profitable crops are to be harvested from the same field for a number of years, and with proper attention in this respect the farm may be made better year by year. The effect of heavy rains is to wash out gullies and ditches and to carry away the soil and plant food as muddy water. If this is allowed to continue unchecked the lightest and most fertile portion of the soil is carried away and the land becomes less productive from year to year. One heavy rain will sometimes carry away from a field more soil than a man with a team and wagon could restore in a week.

It should not be supposed that because land is rolling or hilly, washing must take place. Some very hilly sections which have deep porous soils, full of humus, wash but little, and that only when the ground is frozen to a considerable depth and thaws on the surface. Hard soils that do not readily take up the water that falls upon them wash much more than loose porous soils. The most effective means of preventing washing is to cover the soil with vegetation and loosen the subsoil so that the rainfall can penetrate and be absorbed instead of running off. The rows of corn, moreover, should run at right angles to the direction of the slope. Terraces, when properly placed and well constructed, are effective barriers to soil washing, and their use is to be encouraged. These methods could be profitably employed on the sloping lands near the Ohio and Mississippi rivers. It is the desire of most farmers to have straight corn rows, and on level lands this is preferable, but on hills better success will be obtained by running the rows at the same level around the hills. This will necessitate curved rows, but the curves will usually not be abrupt enough to make cultivation difficult; in fact, cultivation is thus rendered much easier, since it is not necessary to plow up and down the hill, which, to prevent soil washing, should always be avoided.

Absorption of Rainfall.—The carrying away of soluble plant food and lighter portions of soil is not the only objectionable feature

LOOSE SMUT OF BARLEY, VARIOUS STAGES.

of soil washing. The water itself is likely to be needed during some portion of the summer. By loosening the subsoil and covering the surface with a growth of vegetation, the soil can be made so absorbent that the water will penetrate the ground and be held in reserve to sustain the growing plants during times of drought. It would seem that after a period of heavy rainfall, during which 8 or 10 inches of water fell within a month, the soil and subsoil of all fields would be alike saturated, but such is not the case. The condition of the surface soil has much to do in determining how much of the rainfall will be absorbed. The condition of the subsoil is also important. If its moisture has been exhausted by lack of cultivation and injudicious cropping, it will absorb water more slowly than when it is already moist. Thus it is that the subsoil of some fields remains dry to a depth of several feet during a season of heavy rains, while that of other fields absorbs water in sufficient abundance to sustain crops during periods of drought. To readily absorb the water that falls during times of heavy rains the surface soil must be loose and porous, so as to take up the water rapidly before it has time to accumulate, and hold it thus until by capillary attraction it is drawn to the subsoil.

Some very fine clay subsoils are so compact that they turn water almost as effectually as a slate roof. Such subsoils should be rendered permeable, and the most effective and cheapest way to accomplish this is by growing deep-rooted plants, such as clovers, alfalfa, melilotus, etc. The roots of these plants penetrate the subsoil and, decaying, leave numerous ducts through which water from the surface soil will pass to greater depths. That this is exactly what occurs is proved by comparisons of plats of ground on which such plants have been grown with adjacent plats on which they have not been grown. The former plats are tillable soon after heavy rains, because the water has found its way into the subsoil, while the latter plats remain muddy on the surface.

Some subsoils are the reverse of those just referred to; instead of being too compact they are too open. A subsoil of coarse gravel may allow the water to pass through too readily, thus washing out and draining away the fertility. Such subsoils are not compact enough to supply the surface soil with moisture by capillary attraction. Soils of this nature are greatly benefited by the plowing under of vegetable matter, which, besides adding greatly to the soil fertility, checks the rapid leaching through the subsoil and enables it to retain moisture better during dry weather. The application of vegetable matter improves the fertility and physical condition of almost all soils, regardless of whether the subsoil is compact or porous.

Retention of Soil Moisture.—The amount of moisture needed to produce a crop is much greater than would be imagined. In the case of corn it is sufficient to cover the field with water to a depth of from 10 to 15 inches. About three-fifths of this quantity, or from 6 to 9 inches of water, is absorbed by the roots and exhaled by the foliage of the growing crop. More corn crops are cut short by an insufficient quantity of available soil moisture than by any other cause. This is well demonstrated by the fact that fields situated by rivers or lakes

in such a manner that the subsoil always contains sufficient moisture seldom fail to produce good corn crops. The greater portion of the corn-growing area, however, is dependent directly upon the rainfall for its water supply, and it is for this reason that the absorption and retention of water are so important.

After the soil and subsoil have become well supplied with moisture by the rains of fall, winter, and spring, the next important consideration is the means by which it can be retained in the soil constantly within reach of the growing crop. The effect of sunshine and wind is to cause the moisture to pass rapidly from the soil directly into the atmosphere, and unless cultural methods are employed to lessen evaporation much of the soil moisture will pass into the air without benefiting the crop except in a very slight and indirect way. For the good of the crop as much of the soil moisture as possible should pass into the atmosphere through the plants. In this way it will carry the soluble plant food into the plants, whereas if allowed to evaporate from the surface of the soil it will leave the soluble plant food deposited on or near the surface, where it will be inaccessible to the roots until it is cultivated deeper into the soil or washed there by succeeding rains.

As the moisture from the surface evaporates it is replaced by moisture drawn from greater depths by capillary attraction, just as oil is drawn through the wick of a lamp to replace that which is consumed by the flame. The rapidity with which moisture will evaporate from the ground depends upon the condition of the capillary tubes or pores that connect the surface with the deeper soil. Any dry blanket that can be placed between the atmosphere and the damp soil will check this evaporation. The most practical protection is a covering of finely pulverized dry soil 2 or 3 inches deep. By thoroughly loosening the surface layer the soil particles are disarranged so that the capillary tubes are not continuous. In this condition the surface soil becomes quite dry and remains so without absorbing moisture from below, thus acting as a mulch and retaining the moisture within reach of the plant roots. It is necessary that this soil mulch be fine, for if it is composed of clods air circulates between them and causes evaporation to take place from the soil below the surface. A rain, however, will wet the surface, causing the soil to run together and crust, thus restoring capillarity. This makes another cultivation necessary in order to renew the blanket of fine, loose soil.

Fertilizers and Crop Rotation.—A soil lacking in fertility can be made to produce a crop of corn if the requisite amount of nitrogen, potassium, and phosphorus be added and the soil kept in a good physical condition; but the growing of corn on very poor land is usually attended with very little or no profit. It is usually preferable to buy corn rather than to raise it on impoverished soil.

An application of commercial fertilizer may cause a soil to produce one good crop of legumes or other plants, and the roots and foliage of this crop will usually benefit the physical condition and fertility of the soil sufficiently to make other good crops possible without additional applications of fertilizer. The practice to be

guarded against is the robbing of the land. As much vegetable growth should be left on the land as judicious management will permit. Soils are not enriched by rest but by producing crops, provided the crops are left on the land. Of the ten elements necessary to plant growth, nitrogen, potassium, and phosphorus are the ones whose application to soils produces the greatest increase in productivity. Soils composed almost wholly of sand are often deficient in all three of these elements. Soils containing much vegetable matter are not deficient in nitrogen and usually contain sufficient phosphorus. Clay soils may contain sufficient potassium and phosphorus and be deficient in nitrogen. Such soils are made highly productive by growing upon them leguminous crops.

Nitrogen can be added to the soil by applying sodium nitrate, dried blood, tankage, etc., but this element can be more cheaply obtained from the air by growing and plowing under legumes. Potassium can be supplied in the form of potassium chloride or potassium sulphate. Phosphorus can be supplied by applications of ground rock phosphate or ground bone.

If the soil is of such a nature that the application of one or a few elements at a small cost will cause it to produce good corn crops, these elements should be supplied; but if the soil is little more than a foundation, to which must be added a large portion of the necessary plant food, corn growing should be suspended until the soil is permanently enriched by applying large quantities of barnyard manure or by liberal and continued growing and plowing under of leguminous crops. There are many thousand acres of peaty swamp land in Illinois, Indiana, and Wisconsin which, although containing all the elements necessary for plant growth, are caused to produce much more abundantly by applications of potassium. Such land produces little or no corn without potassium, but by such an application will produce good crops.

Nitrogen, which is an essential element of plant growth and the most costly ingredient of chemical fertilizers, in a free state constitutes four-fifths of the atmosphere. By the aid of microscopic organisms leguminous plants, such as clovers, vetches, beans, peas, and the like, extract nitrogen from the atmosphere and store it in the soil in a form available to succeeding crops. This is one of nature's ways of applying fertilizer, and by working in harmony with nature man can hasten these processes and render poor soils fertile in a few years' time and at but slight expense other than for labor. Soils enriched by the growing and plowing under of leguminous plants retain their fertility well, but no soil, unless it be a river bottom which is frequently renewed by overflows, should be planted to corn year after year. The fertility should be maintained and improved by crop rotation and by the turning under of green crops, which can often be grown the same season with the crop grown for profit.

The plowing under of leguminous crops is here given much emphasis because it is the cheapest way of permanently enriching the large areas existing in almost all the States of the Union, and which each year yield poor corn crops because of lack of fertility.

There are some soils already so filled with decaying vegetation that they are not benefited by this treatment, but such soils are limited in area as compared with the extent of heavy tenacious yellow, red, and black clay soils that respond with increased corn production wherever legumes are grown and plowed under. Almost everyone who has farmed such soils has observed through a cornfield a distinct line of variation in vigor, marking the limitation of last year's clover or alfalfa sod.

Soils that have become so completely exhausted that they will not produce a leguminous crop should be inoculated with the proper nitrogen-gathering bacteria, and should receive manure or commercial fertilizers sufficient to produce a crop of some legume. Cowpeas and soy beans are good crops for very poor land. After one such crop has been grown and returned to the soil fertility can be restored by the continued growing and turning under of soiling crops in rotation with other crops.

IMPROVEMENTS IN METHODS OF CULTIVATION.

Methods that produce the best results in some States have failed to produce good results in others. Some sections having fertile soils and good rainfall require for best yields thick planting, while other sections having poor soils or scanty rainfall require thin planting. In some sections with deep soils and subject to prolonged dry weather the best results are obtained by planting in a furrow; while in sections where the land is low and wet, or where the rainfall is excessive, the best results follow when the corn is planted on a ridge. Often adjacent farms possess soils and drainage facilities so different as to demand entirely different methods of cultivation. Rather than attempt to give directions concerning methods best adapted to many various latitudes, conditions of climate and soil, and varieties of corn, some fundamental principles of good corn cultivation, as determined by both practical and experimental corn growers, will be given, leaving it to the judgment of each individual to decide as to which of the principles mentioned can best be adopted in increasing the yield per acre under his particular circumstances. The methods of cultivation in general use in one section of the country differ greatly from those in another section. The implements and methods employed in Iowa are as different from those of Connecticut as these in turn are different from those of Georgia; and while these differences are to some extent due to the nature of the farm land or to the class of labor employed, they are to a still greater extent due to the conservatism of the farmers themselves. That certain kinds of cultivators or plows or methods of planting have been in use in Georgia or Iowa for many years does not prove that implements or methods found successful in other States might not be used there to advantage. It is much too common for the majority of growers in a locality to adhere to methods accepted as best simply because they have been followed for years. They often purchase a particular kind of plow, corn planter, or cultivator because it is the one in general use or the only kind for sale by the local implement dealer, without considering whether some other kind might not be better suited to their farms.

Merchants and manufacturers are so familiar with the methods or machinery of their competitors that any time or labor saving system or device adopted by one soon comes into general use. A similar diligence and enterprise should be exercised by farmers. If every corn grower could visit all the corn-producing States of the Union, the general result would be the discarding of poor and the adopting of improved methods. No section excels in all respects, but almost every section excels in some respect.

Fall Plowing.—Fall plowing can not be recommended for all soils and localities, but should be more generally practiced than at present. If a cover crop or sod is turned under in the autumn, decomposition will increase the amount of plant food available for the crop next summer. This is true to some extent even though sod is not turned under, inasmuch as the simple loosening of the soil admits atmospheric oxygen and increases chemical action upon vegetable and mineral matter. Fall and winter plowing is one of the best methods of combating grubworms, cutworms, and corn-root worms, which are often destructive to corn. Because the surface of ground plowed in the fall is drier at planting time in the spring than that of ground not so treated, it does not necessarily follow that there is less moisture in fall-plowed ground. The fall plowing has enabled the rainfall better to penetrate the subsoil, thus relieving the surface of its excess of moisture. In the spring, fall-plowed fields usually contain much more moisture, but at the same time have a drier surface than fields which remain unplowed until spring. In sections where there is much rain during the winter it is better not to harrow the fall-plowed land in the autumn. This is especially true of fine clay soils that run together and pack readily. In comparative tests of fall and spring plowing, preceding a dry summer, the fall-plowed fields have generally yielded better. The same is true of subsoiling. Deep spring plowing and spring subsoiling are likely to result in diminished crops, especially if done after the spring rains. The loosening of the soil to great depths admits air and facilitates the loss of soil moisture; it also interrupts the capillarity, so that moisture is not as readily drawn from greater depths, and during a dry summer there is not enough available moisture to support a good crop.

From the above it is plain why there has been so much contradictory evidence regarding the best depths to plow for certain crops. For a deep, rich soil deep plowing is best, providing it is done in the fall or does not render the soil too loose and dry. For thin clay soils subsoiling is better than very deep plowing, because it does not turn the compact clay to the surface, yet at the same time loosens the soil to a good depth. The plowing should not be at the same depth from year to year, as by such a practice the soil is not mixed well and a hard surface is left at the bottom of the furrows where the horses walk and the plows drag. A little subsoil turned to the surface occasionally allows the elements to act upon it, liberating plant food, and as it becomes mingled with surface soil and vegetable growth the soil depth will be increased. To accomplish these desired results it is well to plow a little deeper each year for several successive

seasons, and then for one season give a plowing at about half the depth of the deepest plowing. The plow should be so adjusted that it will turn all the soil and leave the surface smooth. In every instance spring-plowed land should be pulverized *the same day* it is plowed. It is well to have the farm mapped, the various fields numbered, and records kept of the annual treatment and production of each field.

Planting.—Throughout all the corn-growing sections of the country it is the general experience that corn planted early most often gives the best yield. Occasionally later plantings yield best, but they are exceptions. Underground drainage will prove most profitable in the end, but as this is rather expensive it is sometimes desirable to use low, flat land for corn before it is possible to have it tile-drained. Sometimes such fields are plowed in small strips or "lands" 4 to 6 feet wide, and a row of corn is planted on the ridge or back-furrow of every land. This places the plants above surface water, and for this reason is satisfactory during wet weather, but the high situation of the stalks is a disadvantage during dry weather.

A little more care can be exercised to advantage as regards dropping a precise number of kernels and covering them with mellow soil when the planting is done by hand, but the labor saved by the use of planters is so great that for profitable corn growing their use is indispensable. Moreover, if the seed bed is in proper condition any good planter can be made to cover corn as satisfactorily as it can be done with a hoe; and, if seed ears having kernels of uniform size be selected and the small and misshaped kernels at the extremities of the ears be rejected, good modern corn-planting machines can be made to drop with sufficient accuracy for practical purposes. However, the yield depends to such an extent upon the proper number of stalks and their even distribution that too much stress can hardly be placed upon the necessity for selecting seed ears having kernels of uniform size and plates for the planter that will drop the right number at the required distance. Every spring the planter should be thoroughly tested and adjusted until it will drop accurately the seed to be used. The kernels of different kinds of corn vary so much in size and shape that it is necessary to adjust the planter to each kind of corn to be planted. These are some of the many essentials that can be attended to before the rush of planting time arrives.

The proper depth to plant must be governed by the quality and moisture of the soil. If it is a stiff, heavy clay containing plenty of moisture at planting time, 1 inch is sufficiently deep; but if it is a light, open, dry soil, 3 or 4 inches is a satisfactory depth. If the corn is planted deeper than 4 inches much of the food supply stored in the seed will be consumed before the young plant can reach the surface and expand its leaves. Plants can not be made to send their roots deeply into the soil by planting the seed deeply. They can better be fortified against dry weather by planting the seed in a furrow, covering it slightly, and then gradually cultivating the furrow full of soil as the plants grow. This requires some care, however, as the furrow should not be filled to any great depth until the plants have

attained a height of 2 feet or more and have established their root systems at the desired depth. This method of planting is especially well adapted to deep soils where dry weather is likely to prevail during the middle or latter part of the growing season. The lister, the implement with which a large part of the corn is planted in the Prairie States, fulfills the requirements of this method of planting.

The lister is used for planting fields that have been thoroughly plowed and also for planting directly in last year's cornfield or stubble field without previous preparation. This latter practice, however, is not recommended for shallow or stiff clay soils.

The results of a majority of the comparative tests in the deep soils of the States just west of the Mississippi River have been in favor of listed rather than surface-planted corn, and the increased yield of listed plats has been greatest in dry seasons. By planting in a deep furrow, as is done with a lister, weeds in the corn rows are more easily covered by cultivation, and as the furrow becomes filled by cultivation the root system is placed at a greater depth. The corn is thus better enabled to endure drought, and the stalks are not so easily blown down. On soils where corn can be listed without previous preparation of the ground this method is profitable because of the labor saved, but it can be successfully employed only on very deep, loose soils. When the drill is attached to the lister one man with three strong horses can do in one day all the work connected with the planting of 7 acres of corn. The drill is so constructed that it can be detached from the lister and used separately. By this means an additional man and horse are required to drill the corn in the furrows made by the lister. If the soil is stiff and heavy it should be well plowed and brought into good condition for planting before the corn is listed. A lister or a planter with lister attachments which lists two rows at once and makes a mark to guide the driver on his return, can then be employed. Disks or double mold-boards can be attached to the various makes of planters and checkrowers, and thereby the corn can be planted in the bottom of furrows below the general surface of the field. For the reasons mentioned, this method of planting would be an improvement for many localities where extensive areas of corn are yearly planted by means of checkrowers which leave the surface of planted fields smooth.

Perhaps more corn is now planted by means of a checkrower than any other device. This implement is adjustable, so that the spacing of the rows and the distance between the plants or hills in the row can be regulated to suit the requirements of the soil. By means of a wire chain stretched across a field one man and team can plant in straight rows in both directions across the field 12 or 15 acres per day, thus admitting of cross cultivation. Corn planted in this way can be kept free from weeds and well cultivated without costly hoeing or the cutting of weeds. A summary of numerous tests made by various state experiment stations shows that there is practically no difference in yield of corn planted in hills of several stalks each or drilled so that the stalks stand separately in the rows, provided there is the same number of stalks per acre in each case. The former system

facilitates cultivation and the latter provides for a more equal distribution of roots throughout the soil. Checkrowers are best adapted to large and comparatively level fields free from trees or stumps. Hillsides and sloping ground can not be planted in checks without increasing the liability to soil washing.

Some successful growers of corn have found it profitable to use a two-row marker set the same width as their checkrower. The checkrower follows in the deep furrows, thus accomplishing all the advantages of both listing and checking.

The distances between rows and the stalks or hills in the rows affect to a great extent the production per acre. A proper number of stalks evenly distributed, so that none will suffer from crowding and so that there will be enough to produce the greatest number of well-formed ears, constitutes the best stand for the production of ear corn. If planted thicker than this the weight of stover increases and the production of good ears decreases. If planted thinner the weight of stover, as well as of ears, decreases. Small-growing varieties should be planted thicker than varieties producing tall stalks.

The distance for planting in a particular soil should be decided upon and the planter adjusted to plant accurately and regularly. Spots missed by the planter, as well as those depleted by crows, insects, etc., greatly decrease the yield per acre. The custom of planting many times thicker than the stand of stalks desired is not a good one. It is a waste of seed and also of labor to thin or "chop out." If the seed germinates poorly it should not be planted, for although a stand may be obtained by very thick planting the stalks will not be thrifty, and a reduced yield will result from using the poor seed. If the seed shows a germination of 97 per cent or more in a thorough germination test, and it is then properly planted, the stand will be almost perfect, unless very adverse weather ensues, in which case all the plants will be so injured that the planting of the entire field again will be preferable to replanting the missing hills and will be more easily accomplished. It is not only a waste of land to have missing hills in a cornfield, but also a waste of labor in cultivating them. If a field has been drilled in but one direction and for any reason a poor stand is obtained, it can be replanted with a checkrower set to drop one kernel at a time and operated without the tripping chain. The checkrower is driven at right angles to the rows of the first planting and is operated so as to plant just as it crosses each row. For this purpose two men will be required, one to drive and one to trip the checkrower as it crosses the corn rows.

IMPORTANCE OF THOROUGH EARLY CULTIVATION.

The most successful corn growers realize the importance of thorough early cultivation, thus preventing any check in the growth of the plants because of weeds or crusted soil. The farmer should see that, from the time of germination to the maturing of the corn, the plants are not subjected to any unfavorable conditions, but are given an opportunity to make a steady, vigorous growth. If their development is checked from any cause they will never fully recover, no matter how favorable the later treatment. As a conse-

quence of heavy rainfall the stalks may increase rapidly in height, and at the same time, for lack of cultivation or of soil fertility, or for other reason, they may be slender or of poor color. Thrifty corn plants are thick, strong, and of dark green color.

Horse weeders and harrows should be used when needed to break a surface crust, check insect depredations, or kill young weeds that start before the corn is up or large enough to be worked with other implements. During the first cultivation, or while the plants are very small, narrow shovels that throw the soil but very little should be used, and fenders are usually found desirable to prevent the covering of the plants.

Many comparative experiments of deep and shallow cultivation have been made, and on the whole the results are in favor of shallow cultivation. There are but few occasions when deep cultivation is preferable. If excessive rains have packed the soil and kept it water soaked deep cultivation will help to dry and aerate it. Breaking the roots of the plants must be avoided so far as possible. If roots are broken the plants will rapidly produce other roots, but it will be at the expense of the vitality and food supply. After the plants have reached a height of 2 or 3 feet, the soil even in the middle of the rows should not be cultivated deeper than 4 inches, and usually a shallower cultivation will prove better. For retaining soil moisture a loose soil mulch 2 or 3 inches in thickness should be maintained.

The best answer to the question of how frequently corn should be cultivated is that it should be cultivated often enough to keep down weeds and to maintain constantly a loose soil mulch till the corn has attained its growth. To this end a greater number of cultivations will be necessary when rains at intervals of about a week cause the surface soil to run together and crust. This crust must be broken and the soil mulch restored, or evaporation will soon rob the soil of its moisture. It is a mistake to think that the longer the drought the more frequent should be the cultivations. After a fine mulch of about 3 inches in depth has been produced, its frequent stirring is not necessary, except in so far as it is required to keep weeds from starting. The essential object of cultivation is to restore the soil mulch as soon after a rain as the condition of the ground will permit. If this time is allowed to pass and the ground becomes hard and baked dry, the crop will suffer greatly, for the cultivation of hard, dry ground breaks it up into clods, allowing the air to penetrate to greater depth and causing more injury than if such cultivation had not been given at all. All observant farmers have seen crops injured in this manner.

Many crops are cut short by stopping the cultivation, because the corn is too tall for use of a double cultivator without breaking down the stalks. If the condition of the soil demands it, shallow cultivation should continue, even though the corn is tasseling.

HARVESTING AND STORING.

Corn as a Forage Crop.—Unless to be used for ensilage or cut green and fed directly to stock, it is very seldom profitable to grow

corn exclusively for forage. Even when grown for the purpose of filling a silo, the feeding value of the crop is very greatly increased by the amount of grain put in the silo. If hay or forage alone is desired, independent of grain, it can usually be more satisfactorily produced by growing alfalfa, clover, cowpeas, or sorghum than by growing corn. In addition to having a higher feeding value than corn stover, alfalfa, clover, or cowpeas will enrich the soil on which they are grown. The removal year after year of crops of corn or sorghum will rapidly impoverish a soil unless an equivalent amount of humus and fertility is returned to it.

Stripping the Blades.—In some sections, especially in the Southern States, the practice of stripping the blades by hand from the standing stalks has for years been one of the established operations in connection with harvesting the corn crop. There is no question that the blades when thus gathered and well stored furnish an excellent forage, but there are cheaper methods of obtaining forage of as good or better quality.

Topping.—It is still quite a common practice in some localities to top the stalks by cutting them just above the ear. By this method the portion of the stalk which is eaten by stock most readily and with least waste is obtained. When the grain crop is late in maturing or wet fall weather prevents the proper drying of the ripening ears, the topping of the corn may be found advisable. If the ears have become hard, the kernels dented, and the husks partly dry before the topping is performed, no reduction in yield will result. A heavy growth of cowpeas may make the cutting of the entire plant impracticable and warrant the topping of the crop. If the corn is desired for seed, topping will facilitate the drying of the ears and thus make it possible to select the seed before it is injured by freezing. Ordinarily, however, it is found more expensive to top a corn crop than to cut and shock the entire plant.

CUTTING AND SHOCKING.

Over large areas in the principal corn-growing States corn is grown primarily for the grain, and each farmer decides for himself how much of the crop will be cut. This is usually determined by cutting just enough to feed the animals maintained on the farm. The chief objection to this method is that many farmers do not maintain enough animals to consume all of the corn stover produced. If the ears are gathered from the standing stalks and no use is made of the stover, fully one-third of the crop is wasted. The term "fodder" is applied to the entire plants as ordinarily cut and shocked, while the term "stover" is applied to the portion remaining after the ears have been pulled or husked.

Generally speaking there is little difference in cost between husking and cribbing corn from the shock and husking and cribbing it from the standing stalk. In some sections men will husk from standing stalks at a lower price than from shocks, but the cost of teams, although they are not usually very busy with other work during corn-husking season, must be taken into consideration. Considering the expense of husking from the standing stalk and from

THE FARMER IN HIS FIELD.

NATIVE PASTURE WHICH HAS NEVER BEEN OVERSTOCKED.

the shock as equal, it is evident that the stover has been obtained for the money paid for having the corn cut and shocked. This cost of cutting and shocking is very much less than the value of the stover if it be properly stored and fed. If left in the field until February or March exposed to the winds and rains of winter, it is questionable whether its feeding value is equal to the cost of cutting and shocking.

Time of Cutting.—In the sections where corn is grown extensively and primarily for the grain, but where it is cut and the stover fed, the time of cutting is governed by the effect which the cutting will have on the ears. When grown for grain it is not advisable to cut until the kernels have become well dented and hard and the husks partly or entirely dried. From the time the corn reaches this condition there is ordinarily a period of about ten days or two weeks in which the stover has a high feeding value and the production of grain per acre is not materially decreased by cutting. After heavy frosts, or after the leaves become brown and the stalks dry, the expense of cutting is greater than the feeding value of the stover obtained. When cut during the period above mentioned, corn stover has approximately the same value as timothy hay. If cutting is delayed until the corn is mature enough to husk and crib or if small shocks of stover are left standing in the field till spring, the feeding value of the product is scarcely worth the expense of feeding it and returning the stalks to the land. There are all kinds of corn stover, and the principal factors governing the quality of any particular kind are time of cutting and care in storing.

The above statements apply to cases in which the corn is grown for grain. The cutting of corn when the ears are in the roasting ear condition or as they are beginning to glaze makes a more palatable stover, but the full feeding value of the crop is not obtained by such early cutting.

Methods of Cutting.—Several methods of cutting are now generally followed: By hand; with a horse cutter drawn as a sled or on wheels between the rows; with a corn binder; and with a corn shocker. In the Northern States the corn binder is very widely used. The stalks attain a height of from 5 to 9 feet and are cut and bound very satisfactorily by means of corn binders. In the extreme north, where the stalks are but 5 feet or less, a wheat binder is sometimes used in cutting and binding the corn crop. The use of the wheat binder for this purpose, however, is not recommended, because the machine is not built for such heavy work. On the river bottoms of the Central and Southern States, where the stalks are large and attain a height of 12 or more feet, with the ears 6 feet or more from the ground, the corn binder does not meet with general favor. Doubtless binders constructed for just such crops as these would meet with greater favor than the binders designed for corn of average height.

The corn binder with bundle carrier is satisfactorily used in cutting corn of average or small size on land that is not very steep or stumpy. On the comparatively level prairie land of the North

Central States the corn binder is very generally used in cutting and shocking corn. In light corn or on level land two horses will suffice, but for faster work or heavy corn the use of three or four horses is much more satisfactory.

In sections where the corn binder is successfully used the principal objections to its use are the cost of twine, which remains upon the fodder but a short time, and the knocking off of ears in the process of binding. In almost all cases the quantity of corn knocked off by the binder is great enough to warrant driving a wagon over the field and gathering the ears from the ground after the corn is cut and shocked. This is necessary because the presence of the shocks in the field prevents the turning in of hogs or cattle to gather up the ears knocked off by the binder.

The use of a binder with a bundle carrier saves very much of the hard labor of cutting and shocking, and the greater ease of handling the fodder when bound into bundles of convenient size saves labor enough to compensate for the twine used.

The stubble cutter should be attached to the corn binder whenever possible, as the early cutting of the stubs hastens their decay and puts the ground in a better condition for the following crop.

Shocking.—No matter what method is employed in cutting the corn, it is very important that the shocks be made and tied in a manner that will cause them to stand erect and keep the fodder dry. Everyone who has husked corn from the shock in the winter or hauled in shocked corn knows the annoyance and great loss due to poor shocking. It would seem as though anyone would know how to shock corn fodder, and especially anyone raised on a farm. Perhaps every one does know how, but the large proportion of twisted and fallen shocks seen in every locality where corn is grown, especially where it is grown extensively, is conclusive evidence that many do not properly shock their fodder. To this carelessness is due the loss of millions of dollars' worth of stover, to say nothing of the grain that is also ruined.

The stalks should be stood evenly about the shocks, with just enough slant to make them stand well against the shock. The slight slant they have should in all cases be toward the center of the shock. Too much slant is very objectionable, because in settling the slant increases and causes the shock to take water. The shocks should be tied as soon as they are made. This will prevent them from twisting or allowing the stalks to blow down before they have settled in place. Some prefer to wait until the fodder has cured a few days before tying, so that they may be tied tighter. A much better method is to tie them when first made and in about ten days tighten the ties. For tying the shocks, binder twine is the most satisfactory. A half-inch rope some 9 or 12 feet long, depending upon the size of the shocks, with a small well-curved hook made of one-half inch iron rod tied in one end of the rope, is of great assistance both in tying and in tightening the ties around the shocks. The rope is placed around the shock near the top and the ring hooked over, and the rope is then drawn tightly and the loose end placed

under in order to hold it securely while the binder twine is being placed in position and tied. If the corn is quite tall there is an inclination to tie the shocks too low. The tying should always be done within 2 or 3 feet of the top of the shock.

In dry climates and where the corn becomes well ripened about the time cool fall weather sets in, the corn shocks should be large—14, 16, or perhaps 18 hills square. Being in the right stage of maturity and with the weather dry and cool, these large shocks will not heat or spoil, and the interior, not being exposed to the rains and wind, will be preserved in a better condition than the outer portion of the shocks. In localities having wet, rainy, and warmer autumns it is necessary to make smaller shocks—8 or 10 hills square. The fodder should not be left in these small shocks longer than is necessary for it to become well cured. In such small shocks nearly all of the stalks are exposed and cure quickly. The corn should then be husked out and the stover placed in larger shocks or the fodder should be hauled to the barn and placed where it will be dry. If allowed to remain in the small shocks, rains will leach from the fodder the soluble and most palatable and nutritious food elements and render the stover dry, brittle, tasteless, and of little feeding value.

It is always best to have the shock rows straight across the field, and if the corn has been checked the shock rows can be made straight in two directions. This is very essential when the ground is to be sown to fall wheat. In this case wide shock rows are advisable, and by means of the corn binder and bundle carrier this result can be easily accomplished.

Jerking and Storing the Ears Unhusked.—Jerking the ears and storing them unhusked is a method of harvesting employed in some sections, especially in the South, where the argument usually given in its favor is that if the husks are on the ears they are more protected from the grain weevil. The destruction of corn by this insect is one of the drawbacks to more extensive corn culture in the South.

As soon as the corn becomes dry enough to crib, weevils are frequently found working under the husks on the kernels of the ears, sometimes to the number of twenty or more to the ear. It is a question worthy of careful experimentation to determine whether the corn is more seriously injured by transferring the weevil with the unhusked ears to the crib than would result were the corn husked in the field, causing the weevils to drop to the ground and thereby leaving most of them in the field.

The total amount of work required to jerk the corn and afterward husk it is considerably greater than that required to husk it directly from the standing stalk, and the quantity of forage obtained by gathering the husks is not sufficient to pay for the extra work. Much better forage could be obtained more cheaply by other methods. If the husks are sold advantageously for mattress making it is well to perform the two operations of jerking the ears and afterward husking them in a manner that will furnish husks of

good quality. The proportion of husk varies greatly among the different kinds of corn, but it is sufficient to say that it requires fully one-half more room to store the ears unhusked than husked.

Husking.—In sections where the farms range in area from 80 to 160 acres and diversified farming is followed so that all of the stover is fed, husking from the shock is a common method of harvesting the ears.

The mistake is sometimes made of husking shocked corn for animals which have plenty of time and would enjoy husking it for themselves. This is true of animals carried through the winter that need no more grain than is found on the quantity of fodder they will eat without waste. This method of feeding can not be followed with animals on full feed, as they would waste the larger quantity of stover in their endeavors to get a full feed of grain and would not obtain as much grain as fattening cattle should eat.

In husking from standing stalks it is customary to have on one side of the wagon a very high throw-board, against which the ears can be tossed and caused to drop into the wagon without the necessity of the husker looking up to see whether the ear has been thrown over the wagon; the noise made by the ear when it strikes against the throw-board is sufficient.

"Lands" are laid out and driven around in husking by this method so that the husker is always on the same side of the wagon and there are no down rows to husk except one for each new land started.

Most successful farmers during corn-harvesting time have each load of corn that comes from the various fields passed over the wagon scales and a record made, so that at the end of the harvest the yield of each field and the quantity of grain stored will be known.

Use of Corn-Picking Machines.—The corn picker is intended to remove the ears from the stalks, which are left in the field. Most of the machines are built on the assumption that the stalks are valueless, and therefore they are practically destroyed. It has not been possible to construct a picker that will not to some extent break down or tear down the stalks. This is somewhat objectionable because, where the corn is picked by hand, the dried corn leaves and stalks serve as roughage for cattle during the fall and winter. The machine has, however, this advantage, that the field can be picked quicker and the cattle turned in earlier to make use of the roughage before the snow falls.

Another objectionable feature of the corn picker as compared with the hand method of picking corn is that it shells considerable corn; and, if the corn is lodged and tangled, more or less ears are missed by the machine. The corn picker with the husker attachment requires considerable motive power, at least four horses being required to pull it. For this reason some manufacturers have dispensed with the husking attachment and depend upon the snapping rollers for removing most of the husks. Machines of this kind will remove from 25 to 75 per cent of the husks, depending upon the stage

of maturity of the corn, the brittleness of the stalks, and the effects of freezing and damp weather. Where machines without the husker attachment are used a stationary husker may be provided at the crib, in which the corn is husked and elevated into the corncrib. For extensive use in large fields that contain few gullies or obstacles corn pickers and huskers can be successfully employed and the crop more quickly harvested, but for the general farmer who with the aid of his regular farm help can husk by hand during the early winter what corn has not been cut for stover these machines are not profitable investments in their present state.

Use of Huskers and Shredders.—The use of shredding machines is becoming quite general in many corn-growing sections. Sometimes the machines are used for shredding the stover after the ears have been husked from the shocks by hand and in other cases both the husking and shredding are done by the machine. The shredding of the stover puts it in a more compact form for storing and a more convenient form for feeding and avoids the troublesome work of handling manure in which there are long coarse corn stalks. Shredded stover is fed with much less waste than stover in any other condition. It has been estimated that shredded stover will go 40 per cent farther in feeding cattle than the whole stalks and considerably farther than when the stalks are put through a feed cutter.

Storing the Stover.—Whether the stover is shredded or not, it is of great importance that it be well stored and not left long exposed to the weather. The mistake is sometimes made of placing the hay crop in sheds and barns and leaving the corn stover in shocks in the field. The reverse is better, inasmuch as most kinds of hay will not depreciate so rapidly in feeding value and will keep better in stacks and ricks than corn stover. Unless placed under cover corn stover should be fed in the fall and early winter. If left exposed until February or March it has little feeding value. There is considerable labor connected with the hauling and storing of corn stover and racks and wagons should be arranged to avoid any unnecessary labor.

In the principal corn-producing States the autumns are usually dry, and corn fodder dries thoroughly in the shocks and is shredded and stored in barns or feed sheds with little danger of heating or molding. The fodder should not be wet when shredded and stored, but damp days are preferable for doing the hauling and shredding because the blades are more pliable and the fodder is therefore handled with less waste. But in some sections, especially in northern States, where the corn is full of sap when cut and where damp fall weather prevails, much care is necessary in storing corn fodder or stover to prevent heating and molding. In such localities it should be placed under cover in ricks not more than 6 or 8 feet in thickness, or, if shredded, layers of dry straw several inches deep should alternate with layers of the shredded stover. The depth of the layers of stover can vary from several inches to a foot or more, according to its dryness when stored. The dry straw will take up some of the moisture from the stover and prevent heating.

Storing the Ears.—There was a time in the history of the corn-

producing belt when rail pens were about the only available means of storing the corn crop. Much to the discredit of some corn growers this method of storing is still in vogue, even in sections where good means of storage could be afforded at little expense. For level ground, double cribs with an elevated driveway and approaches that will enable the loads to be driven through the cribs and dumped or scooped out of the wagons without any high pitching are very satisfactory. On sloping ground equally convenient cribs can be constructed at less expense by extending the crib in such a manner that it can be filled from the upper side and emptied from the lower side. This is a very convenient arrangement, and if the slope of the hill is considerable a driveway can be made below the crib so that with properly constructed chutes the ears can be allowed to roll into the wagons, avoiding the labor of scooping. As the sides should be left as open as possible to permit of a good circulation of air, it is quite necessary that the eaves extend well down over the sides of the crib so as to protect the corn from driving rains and snows.

PROTECTION FROM INSECTS, MICE, AND RATS.

In sections where insects are destructive to stored grain, cleanliness is of value in preventing injury from this source. Small quantities of grain should not be left in the cribs during the summer, as they tend to harbor these pests. Where insects are destructive to the stored grain, it is a good practice to dispose of the entire crop as early as possible and clean the cribs thoroughly, so that there are left few hiding places and no food to carry the insects through the summer.

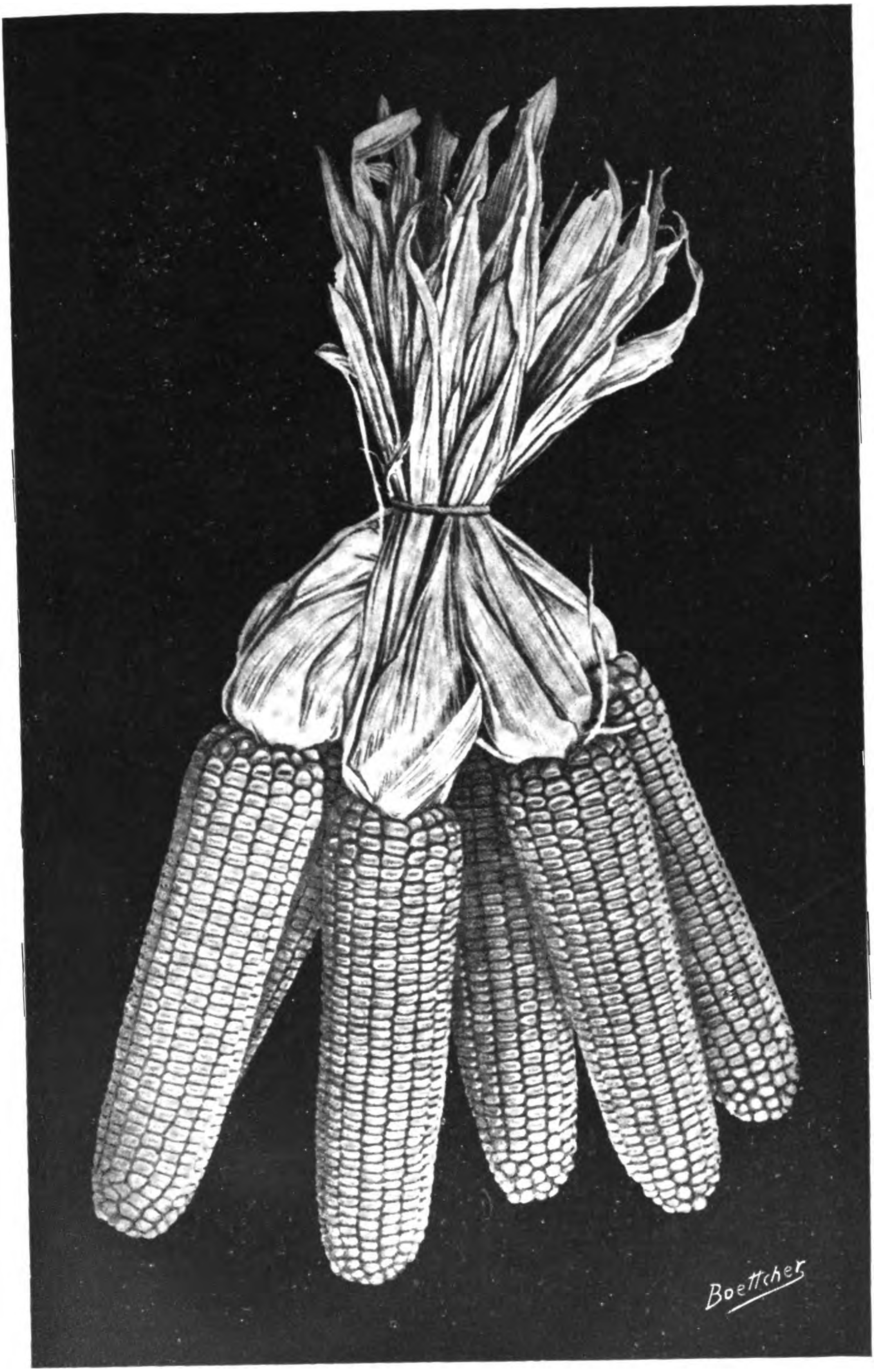
As a protection against rats, mice, and sparrows, galvanized wire netting of about one-fourth-inch mesh can be successfully used in the construction of corncribs. This wire netting can be tacked to the inside of the uprights of the crib, and the strips which constitute the sides of the crib can also be nailed on the inside of the uprights, thus holding the wire netting in place. As a floor, which should be 18 inches or more from the ground, so as not to afford a hiding place for rats, the wire netting can be tacked to the sleepers and the flooring nailed over to hold the wire in place. For overhead protection the wire netting is simply tacked to the joists.

If cribs are built upon solid concrete foundations through which rats can not burrow, no netting will be needed for the floor and the structure can be kept near the ground. With ample roof projection and upper ventilation no danger from dampness need be feared.

CORN CULTURE IN THE SOUTH.

The South has special advantages for the raising of corn, in the long season during which it may be grown and in the ready sale for the crop at remunerative prices. Planting may be done as early as February in the Gulf States, or it may be deferred until after a crop of oats or clover has been gathered from the land in June. Killing frosts rarely occur before November, so that even the latest plantings have ample time to mature, while the early plantings may be harvested in time for growing hay or for sowing winter oats or some other crop on the same ground.

The Soil and Its Preparation.—Any soil which will produce



EARS OF CORN OF U. S. SELECTION 133.

[Adapted to the conditions of southern Wisconsin. Stalks 6 to 7 feet tall; ears 7 to 8 inches in length; ears shell 83 per cent. grain. Matures in 90 days of good growing weather. Field view shown in Plate XIX, fig. 2.]

a good crop of cotton will also produce good corn, although dry, upland clay soils, which will make a fair yield of cotton when well fertilized, are not so well suited to corn as those which are richer in decayed vegetable matter (humus) and so suffer less from drought. Heavy crops of corn can often be grown on soils which produce a too-rank growth of cotton stalks without a corresponding amount of fruit. The best soil for corn is a rich, sandy loam which is well drained and which contains a fair amount of humus. As corn makes a rapid and succulent growth it should be grown on a soil which holds moisture well, and as the weight of the ears bears a close proportion to the size of the stalks the soil can not well be too rich. Humus is of more importance in the retention of moisture than any other one ingredient of the soil, and a loamy soil which is rich in this material seldom suffers from drought.

Owing to the heavy winter rainfall in the Southern States plowing should be done only a short time before planting. Fall plowing for corn is seldom a good practice, excepting on new ground where a tough sod must be rotted before the soil can be made mellow. It is not a good practice to leave the bare soil exposed to the washing and leaching of the winter rains. For this reason, when tough sod land is to be planted in corn it is usually better to plow in the preceding spring or early summer and sow in peas, as the peas will rot and mellow the sod better than any other crop which can be grown, and corn seldom fails to make a heavy yield on land treated in that manner. The plowing should be deep and thorough.

The harrowing should be as thorough as the plowing, and there is no danger that it will be overdone. The harrow should follow the plow very closely in order to pulverize the soil before it becomes dried in hard clods, and if the land is not planted immediately the harrow should be used again just before planting to kill the germinating weed seeds. The labor expended in a thorough preparation of the soil shows its effects through the whole season in the better stand which will be secured, in the less amount of labor needed in cultivation, and in the increased yield.

Rotations.—A crop of cotton occupies the land during the entire year and is a poor preparatory crop for corn, but where it is made the principal crop, as it will always be on many plantations, corn must sometimes follow it, and the best rotation must depend on the proportionate areas which are given to each of the two crops. Where two-thirds or more of the land is used for cotton, with no permanent hay fields, as is very common in the Yazoo Delta and many other rich alluvial regions, a common rotation is: First year, cotton; second year, corn and cowpeas and winter oats and vetch; third year, cotton.

Where only one-half the land is used for cotton, different rotations are more easily arranged. One four-year rotation which gives very good satisfaction is: First year, cotton; second year, cotton; third year, cowpeas and oats and vetch; fourth year, corn and cowpeas. In this rotation the corn is preceded by two legumi-

nous crops, while the cowpeas grown with the corn leave the land in excellent condition for the following cotton crops.

FERTILIZERS.

Red clover, cowpeas, and other leguminous plants are the best fertilizers which can be used for corn. On land which has produced a good crop of any of these plants very little additional fertilizer of any kind is needed to insure a good yield of corn the following season. The abundant supply of nitrogen furnished by these plants affords a large part of that needed by the corn.

VARIETIES.

For all of the ordinary purposes the best variety of corn is the one which will produce the greatest amount of shelled grain per acre, regardless of the time of ripening or of the size of either stalks or ears. In the South the growing season is so long that it is not necessary to select quick-growing varieties. The heaviest yields are commonly secured from varieties which require from 140 to 170 days for their full maturity. If the crop is to be planted on ground from which oats, clover, or some other early crop has been harvested, or on land which has been overflowed until late in the season, some of the earlier maturing sorts should be planted; but when the corn is planted early in the spring any variety will have ample time to mature before frost.

PLANTING.

Whether corn should be planted flat or on raised beds will depend on whether the land has good natural drainage or is liable to suffer from overflows. With good drainage flat planting is much the better, because preparation is less expensive and because it exposes less surface for the evaporation of soil moisture, and thus makes the crop less liable to suffer from drought.

The rolling lands of the South so often suffer from washing that it is usually necessary to preserve them as much as possible by planting in drills rather than in checks. The rows should run at right angles to the slope of the hill, so as to keep them as nearly level as possible, and although this makes the rows irregular in length and in distance apart, it is the only safe plan to follow on lands which wash. In most cases "circling" the rows around a hill is fully as effective as is the ordinary form of terracing, as each row forms a miniature terrace 4 feet wide and no space is lost.

CULTIVATION.

The nearer level and smooth the surface of the ground can be kept the better. Thorough cultivation is needed, but that does not mean deep cultivation. While corn does best on a soil which is deep and loose, the deepening and loosening of the lower soil should be done before the corn is planted, and the shallower the later cultivations can be kept the more satisfactory will be the results. Corn has no large taproot like that of cotton, but is a surface feeder, having a large number of long roots distributed through the upper soil, and whenever the soil is cultivated so deep as to disturb any of the roots the plant is necessarily weakened by having its supply of moisture and nourishment decreased. A constant supply of food

is as necessary to a growing plant as to a growing animal, and the cutting off of so many of the corn roots as is done by cultivating 4 or 5 inches deep gives the plants a check from which they never fully recover. Cultivate the ground deeply before planting and as shallow as possible afterwards.

HARVESTING AND STORING THE CORN.

The more common method of harvesting the crop is to "pull" the ears, with a good portion of the husks attached, leaving all the fodder in the field. After the crop has been gathered hogs and cattle are turned into the fields and so a portion of the fodder is utilized. This seems like a wasteful method, but in a region where the cornstalks are usually large and coarse and where hay can be made and saved with so little expense it is often the most economical and profitable plan. Whether to cut the stalks and save them for coarse feed or to give cattle the range of the field and use the labor in making other hay depends on the amounts of feed which can be secured by equal amounts of labor. When the entire stalk is saved the yield of dry forage per acre is from 1½ to 2 tons, and of that amount approximately one-fourth, and that the part which is the most palatable and has the greatest feeding value, may be saved by turning stock into the field. Taking into account the amount which will be gathered by cattle without expense and the various losses in handling and feeding the stalks the total additional amount of feed saved by cutting is rarely more than 1 ton per acre. To secure this additional ton the entire crop must be cut, and in order to make more than half the weight of fodder available for food all must be run through a shredder, thoroughly dried, and stored in a dry place. The palatability of the shredded fodder varies greatly. If the cutting is done early, while the upper leaves are still green and the stalk is not yet dry, the yield of fodder will be much heavier and of much better quality than when the cutting is done later, but the early cutting will cause a loss in the grain yield and the fodder will be more difficult to cure. The only object in saving the fodder is to secure a given amount of forage for feeding stock. On many plantations an equal amount of forage of better quality can be secured if the labor necessary for saving the corn fodder is used in making and saving hay, and the farmer who adopts either of the rotations suggested on a previous page will rarely find it profitable to cut, shred, and house his cornstalks.

When corn is to be used during the winter for feeding fifteen or more milch cows it is economical to use a part of the crop in filling a silo.

CORN BREEDING.

The farmer who will produce a productive strain of corn adapted to his section will be able to sell good seed at a price profitable alike to himself and to those who buy, and will become a public benefactor by increasing the production of corn in his neighborhood.

A good corn for any section is a corn that matures in time to escape frost or drought and that produces grain or shelled corn of good quality abundantly. An error is very frequently made in

northern sections in attempting to grow a corn that is not sufficiently early in maturing. On the other hand, a corn should be sufficiently late in maturing to utilize the entire period of good growing weather, as longer growth is favorable to greater production. In the following descriptions of the characters that constitute desirable stocks, ears, and kernels, only the most important characters—those that influence the production of grain per acre—are considered.

Desirable Stalks.—A desirable stalk is one without suckers, or offshoots, thick at the base, with well-developed roots, gradually tapering toward the top, and bearing a good ear or ears slightly below its middle point. It is perhaps not advisable, even in the Southern States, to obtain a taller growth of stalk than 10 feet, and in the extreme North the short growing season does not permit of more than half this growth of stalk. The stalk should be free from smut or other disease, possess well-formed blades, preferably 12 to 16, and have its ear attached by an ear stalk, or shank, not more than 4 or 5 inches in length. Select seed ears from stalks that are well developed, and this can be done only by selecting from standing stalks at ripening time.

CLOSE EXAMINATION OF EARS SELECTED.

The hundred or more desirable ears which have been selected should be placed on boards or tables, with the tips of the ears pointing in the same direction. One by one each ear of the lot should be compared with the sample ear, which should be the one that most nearly approaches the typical ear, and any that do not conform to type should be discarded. Two or more kernels, one a third of the distance from the butt and another the same distance from the tip, should be taken from each ear and examined and measured. If these kernels are too short, or are found defective in any character, the ear should be discarded.

The ears that have proved suitable should be thoroughly dried and well preserved till nearly planting time, when they should be shelled by hand, the poorly shaped kernels at the extremities being discarded and the good kernels placed in small paper bags, the kernels from each ear in a separate bag.

SELECTING A BREEDING PLAT.

In the breeding plat the best seed ears are planted in separate parallel rows, one ear to each row. This is necessary in order to determine which ears possess the invisible character of great productiveness to the highest degree. It is essential that the soil of the plat be uniform and that the various rows be given the same opportunity in all respects. Dead furrows and back furrows should be avoided. In case they are present, the rows should be planted at right angles to them; otherwise a row close to a dead furrow or back furrow might be placed at a great advantage or as great a disadvantage. If one side of the patch is higher than the other the rows should be planted so that each will have an equal amount of high and low land. These points are exceedingly important, for

unless the rows all have an equal chance the results of the test become unreliable.

The breeding plat should be located on land of the same nature and degree of fertility as the farm or the soil in general on which the seed produced in the breeding plat is to be planted. It is a mistake to give the seed plat extra care in the way of heavy fertilization or irrigation. The object of the breeding plat is to increase in a strain of corn the property of producing heavily under the natural conditions of the locality. This property is transmitted by selecting seed from the progeny of ears that give heaviest yields, not because of having grown on rich soil, but because of possessing an inherent tendency to great production. By locating the seed plat on soil similar to that of the neighborhood the strain of corn from year to year becomes better adapted to soil of that nature.

In all corn-breeding work isolation is essential. The breeding plat should be separated from other kinds of corn, and even from inferior strains of the same kind, by at least 40 rods. A greater distance is safer, though if strips of timber or hills intervene there is less likelihood of the winds carrying to the breeding plat pollen grains from inferior corns. The tasseling of volunteer corn stalks near the breeding plat must be prevented.

The size of the breeding plat can be suited to the size of the farm and to the labor available for the work. From 40 to 60 corn rows of exactly the same length—from 500 to 600 feet long—would form a plat of very desirable size. If the work be with a small-eared corn it will be necessary to have the rows shorter. A very small breeding plat should not be used. The results of the yields are not so trustworthy, and in planting but a few ears there is less chance of finding one possessing especially high producing power.

PLANTING THE BREEDING PLAT.

It is better to drill the corn in the breeding plat rather than to plant it in hills. If planted in hills it is impossible in some cases to distinguish suckers from the main stalks. The grower should use the utmost care to get a uniform stand of stalks in all the rows. The fertility of the soil and the available moisture will decide how thick the stand of stalks should be, but it should be the same as for other cornfields planted on similar soil. For convenience in labeling the seed selected from the various rows, it is best to number the rows by means of stakes at one end.

In order that all the rows may be similarly situated, a few border rows should be planted entirely around the breeding plat. Such border rows will often protect the breeding rows from depredations of crows, squirrels, chinch bugs, etc.

The seed used in planting the border rows should of course be from very select ears. Usually enough is left of the ears used in planting the breeding rows to plant the border rows.

The breeding plat should be given the same good cultivation that other cornfields require.

DETASSELING TO PREVENT SELF-POLLINATION.

Before the corn comes into tassel, or even earlier, a few rows

may exhibit marked weakness. Such rows should have the tassels pulled from all the stalks as soon as the tassels show plainly in the top of the stalks and before pollen is discharged. In the same manner the tassels should be pulled from all the undesirable stalks in all the rows. Undesirable stalks consist of barren stalks, stalks with many suckers, feeble or very slender stalks, smutty stalks, etc. If detasseled in time the transmission of these characters to the next generation will be prevented.

In order that seed may be selected that has to no extent been self-pollinated, one-half of each row is detasseled. That this may not interfere with proper pollination, it is performed as here illustrated:

Row 1........................————————————————————
Row 2 ————————————————————........................
Row 3........................————————————————————
Row 4————————————————————........................

Each row is detasseled from one end to the middle, alternating ends of adjoining rows being detasseled. After the detasseling is finished there is no work to be done in connection with the breeding plat until the stalks turn brown and the ears begin to dry. An exact count should then be made and recorded of the total number of stalks, including suckers, contained in each row.

SELECTING SEED FROM THE BREEDING PLAT.

When the majority of the stalks are ripe and the husks and ears are fairly dry, the detasseled portion of each row should be gone over separately, and the ears from all desirable stalks gathered, weighed and at once spread out to dry, the row number being kept with each lot of ears. Of course it is only from ten or a dozen of the most productive rows that we wish finally to retain seed for planting; but, as we can not know the most productive rows until the yield from each row is weighed, it is necessary to select seed from all the rows except those that are conspicuously poor or weak. Such rows should be entirely ignored, as should also any rows that have a poor stand of stalks. This is important, because no test of production can be made unless the stand is quite uniform.

When dry enough to harvest, the ears from each row should be gathered and weighed, and the weight of corn from each row added to the weight of the seed ears that were previously gathered from the same row. This addition gives the total number of pounds produced by each row.

DETERMINATION OF THE MOST PRODUCTIVE ROWS.

It is impossible to secure exactly the same number of stalks in all the rows at harvest time, and the row that contains the most stalks will have the advantage unless the stand is too thick to allow of greatest production. Ignoring the rows that fall much below a perfect stand, the others should be ranked according to their average production per stalk, which is obtained by dividing the number of pounds produced by a row by the number of stalks that grow in the row. The secret of a large corn crop lies in having each stalk produce well. By taking seed ears from detasseled stalks that

produce well and which grew from ears of high producing power, progress is made each year in increasing the yielding power of the strain.

Having now calculated the average production per stalk of each row in the breeding patch, except the conspicuously poor ones, the best ears from the ten or dozen highest ranking rows are examined, kernels measured, etc., and six to ten of the very best ears from each of the highest ranking rows preserved for the next year's breeding plat. A similar number of second-best ears are also preserved, as a safeguard against losing the work of previous years in case hail, floods, or insects should destroy the breeding plat. After the improvement has been continued for a few years it is exceedingly important to save this extra supply of seed. The work as outlined is repeated each year, and the improvement from year to year is very noticeable and gratifying to the breeder.

THE INCREASE FIELD.

It is not supposed that seed in sufficient quantity for general planting or for sale will be obtained from the rows of the breeding plat. The method has been outlined for the purpose of showing how a highly productive strain is originated. To obtain seed for general planting and for sale, an increase field is grown from the remaining seed obtained from the desirable stalks of the detasseled portion of the highest-ranking rows. Due precaution is taken to prevent the increase plat from being cross-fertilized with inferior strains. Otherwise it is planted and cared for as any other cornfield. It is called the "increase field" because it is used to increase the quantity of well-bred seed produced in the breeding plat. The increase field is not grown for the purpose of improving the strain of corn, but solely for the purpose of increasing the quantity of good seed of the strain improved by the necessarily complex method outlined.

The breeding plat will each succeeding season furnish seed more highly improved for planting the increase field. From the increase field seed is obtained in large quantities for general planting and for sale. For these purposes the good seed ears can by some convenient and rapid process be separated from poor ones. This can be done most handily, perhaps, as the wagonloads of corn from the increase field are being unloaded at the cribs.

CORN AND CORN PRODUCTS AS FOOD.

In the United States corn is by far the most important cereal, and is grown in every State, though the southeastern and middle western sections are the great corn regions. The greater part of the corn crop is used for feeding live stock and poultry, or for starch making or other manufacturing purposes. Nevertheless, corn has always been and still is a favorite and very important source of human food in America, and especially in the South Atlantic States, where it ranks with wheat as a breadstuff.

The germ of corn makes up an unusually large percentage of the kernel as compared with most grains, and as the germ is very rich in fat the grain as a whole is characterized by an unusually

large proportion of this constituent. The proportion of protein is also fairly high. Carbohydrates, particularly starch, make up the greater part of the nutritive material of corn, as of other cereals. Until about fifty years ago corn was simply ground and then bolted or sifted at the mill or at home in making meal for cookery, but now it is usually kiln-dried and deprived of the outer skin and germ before grinding. The modern granulated corn meal is bolted to free it from offal products and is finer and keeps better than the old-fashioned sort, though it does not differ from it very materially in composition except that it contains a little less fat and crude fiber. The removal of the corn oil modifies the flavor, though it undoubtedly improves the keeping qualities. In general, corn meal contains a little more fat and starch and a little less protein than wheat flour, but after all it resembles this staple foodstuff quite closely in chemical composition.

The changes brought about in corn by the heat of cooking are much the same as those observed in other cereal grains. Thus, the cell walls made up of indigestible crude fiber are softened and broken down and so the starch inside may be more readily reached by the digestive juices. Heat, with or without the presence of water, changes some of the insoluble starch into forms which are easily dissolved, a condition favorable for digestion. Cooking has further advantages in that it improves the flavor of corn and thoroughly sterilizes it, a matter which may be very important under some conditions.

Corn protein does not contain the elastic, tenacious gluten which is characteristic of wheat protein and so corn meal does not give a light porous loaf with yeast. For this reason corn meal alone is seldom used for raised bread, but is usually baked in thin cakes which are granular rather than porous, although such leavening material as eggs, sour milk with soda, etc., may be used in making the batter. When corn meal is mixed with wheat flour or rye flour the dough may be raised with yeast. Such bread, of which "rye and Indian" bread is a typical example, is most palatable when slowly cooked in rather large loaves. Corn meal is often used for making mush or porridge. Under the name "hasty pudding," this dish used to be a favorite in New England and is still frequently served as a supper dish.

Samp and hominy, which are much less finely ground than corn meal, are cooked like other grits and are commonly used as a breakfast cereal or as a vegetable to accompany meat. Hominy is now frequently made without the skin and germ. Like other similar cereal goods hominy and samp require long-continued and thorough cooking, especially when coarse.

Hulled corn is an old-fashioned dish in which the kernels, instead of being ground or degerminated, are steeped in lye until the hulls are loosened, soaked in clear water until free from alkali, and then boiled until soft and tender.

There are various proprietary breakfast foods made from corn. In most of these the grain has been cooked until tender and then

rolled or flaked and sometimes parched with or without the addition of malt or other flavoring material.

Cornstarch has long been an important foodstuff commonly used for making puddings and desserts and for invalid cookery. Glucose made from cornstarch is a very common commercial product. The use of corn oil as a culinary fat is comparatively recent but seems promising.

Corn meal and other corn products are used in making an endless variety of batter breads, cakes, and other dishes for which recipes may be found in books devoted to cookery.

Unripe or green corn is frequently used as a vegetable, particularly in America. Like all green vegetables it is succulent and contains a small amount of nutritive material in proportion to its bulk, being esteemed for its pleasing flavor and the variety which it gives to the diet rather than for its direct food value. Corn canned alone or mixed with beans or tomatoes is a common commercial product, reasonable in price, and a useful addition to the list of vegetables, particularly in the winter diet.

Careful experiments made to test the digestibility of corn indicate that the carbohydrates are almost completely utilized by the body no matter how the grain is cooked. The method of preparation, however, apparently makes considerable difference in the digestibility of the protein. Thin, porous corn bread, such as johnnycake, and even the thick loaves of Boston brown bread, made of equal parts of corn, rye, and wheat, furnished as large a proportion of digestible protein as white wheat bread raised with yeast. On the other hand, the protein of hoecake (cornmeal mixed with water and baked in thin sheets) has been found to be slightly less digestible than that of wheat bread, while the protein of hasty pudding and boiled hominy is only about 73 per cent digestible as compared with 83 to 86 per cent in the above-mentioned type of corn bread.

The corn breakfast foods and other corn products have much the same digestibility as corn meal when cooked in similar ways. The variations which have been noted with the different corn breads and other corn dishes are of the same character as those observed with similar foods made from wheat flour of different sorts.

Corn, though a wholesome and very useful foodstuff which may be cooked in many ways, is not likely to replace wheat as a leading breadstuff where the latter can be obtained, as wheat bread is commonly considered to be more appetizing for everyday use and has an advantage in that it keeps for a longer time in good condition after baking. Corn breads, however, give a pleasant variety to the diet, and being more easily and quickly made than wheat bread are especially useful when hot bread is wanted and time is limited. Corn breads and corn cakes are so easily made that they are favorites in camps and wherever cooking appliances are few and simple.

Where conditions are especially favorable to corn cultivation, as in the mountain districts of the southeastern United States, some parts of Italy, and the Balkan regions of Europe, corn is often the staple cereal food and not infrequently the principal article of diet

for the poor. In times of distress people have lived on this grain alone for considerable periods, but, like other grains, it contains too little protein in proportion to its fat and carbohydrates to supply the body with nutritive material in the proper proportion, and it should be combined with materials rich in protein, such as lean meat, milk, cheese, dry beans, etc. When thus combined it is a healthy, nutritious, and inexpensive food and has been proved by common experience to be wholesome, palatable, and a welcome addition to the diet.

Considering all of its uses, corn is one of the most important cereal foods from the standpoint of palatability, nutritive value, and digestibility. It may be prepared for the table in a great variety of ways, and in some form or other is deservedly used in the majority of American homes.

(*Corn References.*—F. B. 81, 199, 229, 253, 298, 303, 313, 400, 409, 414, 415; B. P. I. 73, 81, 161, 191, 199; Div. Botany 23; Y. B. 1909, 1910; Ala. A. E. S. 111, 138, 142, 154; Tuskegee Nor. and Ind. Inst. 15; U. Arizona A. E. S. 54; U. Ark. A. E. S. Cir 3, 1910, Bul. 59; Colo. Agr. Col. E. S. 57; Conn. A. E. S. Rpt. 1907; Del. Col. A. E. S. 11, 14, 77; Fla. St. Agr. Col. E. S. 7; Ga. E. S. 46, 51, 55, 69, 74, 78, 84, 88; U. Idaho A. E. S. 5, 1905; U. Ill. A. E. S. 20, 46, 53, 63, 82, 87, 96, 100, 119, 126, 128, 132, 148, Cir. 101, 1906; Purdue U. A. E. S. 23, 43, 50, 77, 105, 110, 117, 139, 149, Cir. 2, 1908; Iowa St. Col. A. E. S. 45, 55, 68, 77; Kans. St. Agr. Col. E. S. 17, 27, 30, 45, 56, 64, 107, 127, 139, 144, 147; Ky. Agr. E. S. 118, 122, 145; La. St. A. E. S. 7, 8, 111, 118; Md. A. E. S. 141; Mich. St. Agr. Col. E. S. 20, 28, 34, 47, 52, 212; U. Minn. 7, 15, 81, 107; Mo. Agr. Col. E. S. 9, 19, 36, 59, 87, 212, Cir. 45, 1910, 50, 1911; U. Nebr. A. E. S. 91; N. H. Col. A. E. S. 71, 151; Cornell U. A. E. S. 42; N. C. A. E. S. 204; N. Dak. A. E. S. 36, 51, 79; Ohio A. E. S. 140, Cir. 42, 53, 61, 66, 71, 74, 86, 117; R. I. A. E. S. 113, 116; S. C. A. E. S. 14, 124, 135; U. Tenn. A. E. S. 89; Texas A. E. S. 49, 120; Utah Agr. Col. E. S. 66; Va. A. E. S. 165; Wash. St. Agr. E. S. 38; U. Wis. A. E. S. Cir. 8, 1909, 18, 1910.)

WHEAT.

Wheat is the world's choicest bread crop and the source of one of the principal foods of the most progressive and intelligent nations. Rice is the only other crop used by a larger portion of the human family. The United States is the leading wheat-producing country of the world, and it is of the greatest importance that its rank in this respect be maintained.

Owing to the wide geographical distribution of the plant, the varieties of wheat are more numerous than those of any other cereal. In addition to the botanical classification, a number of other classifications are in use, as, for instance, the market classification embracing the different types recognized by the grain markets, such as soft winter, hard winter, hard spring, and white wheats; the classification based on external characters, which groups the varieties into spring and winter wheats, bearded or awned, and beardless or bald varieties, white and red wheats, hard

and soft sorts, early and late varieties, etc. The soft wheats are also called starchy wheats and the hard wheats glutinous wheats. The bread wheats include all varieties excepting those used in the preparation of macaroni, spaghetti, and other pastes.

Varieties of wheat differ greatly in productiveness, hardiness, drought resistance, resistance to lodging, quality of grain, and in other characters. There are always best varieties for certain soils and regions but no varieties that succeed best under all conditions. It costs no more to grow a good variety than a poor one, and it is therefore to the farmer's interest to secure the best sort for his locality. All varieties grown in the vicinity should be observed and the best one selected. Such a variety is more likely to give satisfactory results than one brought from a distance because there will be little or no change in its environment.

Wheat varieties are improved mainly by selection and crossing. Improvement by selection comprises the selection of seed and the selection of individual plants. Varieties may be improved by selection or by crossing and selection together. Most varieties now grown are the result of simple selection, and this kind of work is often very profitable and replete with satisfaction. Dawson Golden Chaff, for instance, had its origin in a single stool of White Clawson wheat which had been the only one to survive the winter in a bare and exposed position. This variety has given excellent results in New York, Michigan, and Canada, and is a standard sort in many localities. This instance is one of the many showing the importance of selecting individual plants.

The crossing of varieties is effected by means of artificial cross-fertilization. The stamens must be removed from the blossom before the pollen sacks are mature enough to break and to pollinate the pistil. After this is done the pistil must be protected from the pollen of other flowers borne either in the same or in other heads. Usually all the flowers not desired for crossing are removed and the entire head is then wrapped in tissue paper and the pollen of the variety chosen as the male parent applied to the stigmas when these are in proper condition. As soon as the application of pollen is made the heads are carefully covered to keep other pollen from entering and possibly fertilizing the blossom. The resulting seed is planted and the crops for several years are subjected to rigid selection to fix the variety.

Soil.—Light fertile clay and medium fertile loam soils of good depth and well drained are best adapted to wheat culture. Heavy clays are too compact and are inclined to bake, while highly fertile loams tend to lodge the crop. Light clay soils have the proper degree of compactness and are sufficiently retentive of moisture and better adapted to winter wheat and uniform seasons than the loams. The clay soils are usually uplands, while the loam soils are either lowlands or prairies. The alluvial soils of river bottoms, if not too rich, usually make good wheat lands, because they are deep and fertile and generally made up of clay, sand, and humus in proportions, making them friable and porous and giving good drainage.

The loams are primarily corn lands, but in connection with corn culture are well suited to spring wheat. Very light, loose or sandy soils and wet, peaty, sour lands are unfit for the wheat crop.

Drainage is necessary to a profitable development of the wheat plant, and a permeable subsoil is especially important during the most active stages of its growth and to winter wheat also in the late fall and winter. Where the subsoil is not sufficiently permeable, proper drainage should be provided by putting down tile, as this is generally the most satisfactory and economical method of draining.

The character of the soil influences the yield to a greater extent than it affects the quality, which is largely controlled by climatic conditions. That the two factors are closely connected is shown by the durum wheats, which require rich humus soils and hot and dry seasons. Rich soils increase the protein content of the grain and also tend to increase its hardiness.

Deep plowing is not of general value and often seems to affect the yield of straw more than the yield of grain. Plowing from 4 to 6 inches deep is adequate, especially if the land is in good tilth. Subsoiling is expensive and frequently unprofitable in wheat culture. On friable and mellow soils plowing is unnecessary if the land was well cultivated the year before in connection with growing corn. On such land a seed bed can be prepared by disking or cultivating and harrowing.

If the plowing is done when it is too wet the soil is likely to harden or bake, and if done when too dry the ground remains rough and lumpy. It should be remembered that in growing wheat and other similar plants the tillage of the crop, as it were, is performed before and at the time the seed is sown. In the semiarid regions the success of the crop depends often entirely upon the careful and thorough cultural treatment given the land.

Corn stubble should be broken down to the ground when the soil is frozen. For this purpose a heavy square timber or a railroad iron drawn by hitching one or two horses to either end can be utilized. Cornstalk cutters are in some cases useful, but a sharp disk harrow often makes it unnecessary to use a stalk cutter, even where the corn was husked from the standing stalks. In some cases it will be wise to thoroughly pulverize the corn stubble land before seeding, so that a drill may be used to advantage. In other cases the better plan is to sow the wheat broadcast and cover with the disk harrow, the corn cultivator, or other implement which will turn the soil up to the depth of two or three inches. In case a farmer has only a shoe drill, that implement may be successfully used instead of the broadcast seeder, where the disk is to follow the sowing. By drilling the wheat in shallow, it is so placed that it will be turned under by the disk or other cultivator. Any good method which plants the wheat at the proper depth and leaves the surface soil level and smooth will succeed.

Grass sod should be fall-plowed for wheat. Early plowing is often the better for timothy, while in case there is growing a heavy second crop of clover it is wiser to defer the plowing until a crop

can be removed or until it has developed a large tonnage of green manure. The crop is worth more for feed than for green manure, if there is at hand profitable live stock to make use of it, since the manure can largely be returned to the land. Grass makes a good preparation for wheat; while the atmospheric nitrogen added by the clover to those soils which have been depleted of this fertilizing substance often increases the following crop of grain several bushels per acre.

Stubble land after small grain crops is of necessity, or of choice, very much used for crops of wheat. This land cannot be gotten into good mechanical condition for wheat. The stubble and weeds are coarse, do not quickly decay into humus, and tend to make the furrow slice too loose for capillary water to rise into it, and too open, allowing too free circulation of air. Wherever practicable, in a climate which is subject to periods of drought, and in which grain crops are planted continuously, it pays to burn the stubble and weeds. The fire destroys many weed seeds, and destroys the coarse materials which would do more harm than good. The extra cost of making less than a ton of barnyard manure to take the place of the humus-making stubble and of the nitrogen lost in burning is far less than the loss arising from coarse stubble in the furrow slice and weed seeds in the soil. Burning the stubble and not making manure by keeping live stock is, however, undoubtedly harmful to the soil.

But, taking into consideration all things, early autumn plowing is the most important point in the preparation of stubble land for wheat. By early plowing many weeds will be covered before the seeds have ripened, the stubble will have some time in which to become softened and rotted, and the soil will be compacted through the influence of the fall rains, and will have its capillary connections made more intimate with the subsoil.

In the spring care should be taken in preparing the seed bed to thoroughly pulverize the upper two or three inches of soil. Where the winds are not likely to cause the soil to drift, it is wise to make the surface fine and smooth. Where drifting occurs it is necessary to leave the seed bed coarser, and especially to avoid using the roller, or the plank or "floater."

Manuring.—The fertility of wheat land may be maintained and improved by the use of barnyard manure, commercial fertilizers, and green manures, and by proper crop rotations and fallowing. No general applicable rule for fertilizing wheat lands can be laid down, but certain underlying principles are operative everywhere. Wheat straw contains approximately 0.6 per cent of nitrogen, 0.2 per cent of phosphoric acid, and 0.6 per cent of potash, and the grain about 2 per cent of nitrogen, 0.85 per cent of phosphoric acid, and 0.55 per cent of potash. This means that a ton of straw removes from the soil 12 pounds of nitrogen, 4 pounds of phosphoric acid, and 12 pounds of potash, and a ton of grain, or 33 1-3 bushels, 40 pounds of nitrogen, 17 pounds of phosphoric acid, and 11 pounds of potash. As nitrogen is valued approximately at 16 cents per

pound, and phosphoric acid and potash at 5 cents, a ton of straw represents a cash value of $1.92 for nitrogen, 20 cents for phosphoric acid, and 60 cents for potash, or a total of $2.72, while the essential fertilizing elements contained in a ton of the grain would cost $6.40 for nitrogen, 85 cents for phosphoric acid, and 55 cents for potash, or in all $7.80 if bought in an available form in commercial fertilizers. These figures call attention to the importance of returning at least the straw in the form of manure to the land and also point to the fact that continued wheat growing for the market must deplete the fertility of the soil.

Barnyard manure is preferably applied to the corn before wheat. When manure is directly applied to winter wheat it should be spread and plowed under immediately after the preceding crop is removed, in order that it may become well embedded in the soil before the seed is sown. In such cases the use of 10 tons per acre is sufficient and will generally give better results than double that quantity. When barnyard manure is used as a top-dressing for wheat it should be well rotted and finely divided, and preferably spread with a wide-tired manure spreader. On most loams and alluvial soils, which grow wheat in rotation, the use of barnyard manure—especially its direct use—is unnecessary, but on light clay soils it often proves profitable.

The application of large quantities of available nitrogen, either in commercial fertilizers or barnyard manure, usually results in a heavy growth of straw and a consequent tendency to lodge. A complete fertilizer, or one containing nitrogen, phosphoric acid, and potash, is generally to be recommended, and while no rule applicable to all cases can be laid down, the use of 300 to 500 pounds of a fertilizer mixture furnishing in plant food 3.3 per cent of nitrogen, 12 per cent of available phosphoric acid, and 4 per cent of potash is quite common. On poor soils the application of nitrogen and potash may be relatively high, while on soils in a fairly good state of fertility the phosphoric acid should be relatively increased, as comparatively large quantities of this substance in the form of superphosphate or soluble phosphates act favorably on the crop in that they tend to prevent or reduce lodging. Commercial fertilizers are more profitable as a rule on clay soils than on the richer loams, and throughout the western wheat area of the country they are little used. Applications of 25 to 40 bushels of lime per acre are often very beneficial, especially on soils treated with sulphate and chlorid of ammonia for a series of years. Top-dressings with nitrate of soda are sometimes given after the crop has made some growth, but if the plants are in a vigorous condition in the spring no top-dressing is necessary.

Green manuring with leguminous crops is very desirable, but when a heavy green crop is plowed under it is best to follow it with a hoed crop before putting the land into wheat. Benefit is also derived when leguminous plants are grown before wheat and other crops and only the stubble is plowed under.

Summer fallowing, which is seldom followed in humid sec-

tions, is practiced quite extensively in some of the wheat regions on the Pacific coast and in those western States where dry farming methods are required. To mature profitable crops the land in these sections requires the rainfall of two seasons, and hence wheat is generally grown on land which has had a season of rest and has stored up sufficient moisture to supply the demands of the crop. Cultivation of the summer fallow is practiced to conserve the soil moisture and to increase the store of available plant food which reduces the water requirements of crops. On lands which receive adequate rainfall summer fallow can not be as profitable as the culture of some leguminous crop, which not only adds nitrogen and humus to the soil, but also prevents, or at least largely reduces, leaching.

Seed and Seeding.—The grains of seed wheat besides being all of one variety should also be heavy, plump, and spherical, and free from dirt, weed seeds, and injured or immature kernels. Experiments show that it pays to use the fanning mill in grading wheat for seed. Even if the seed be clean, that is, clean with respect to such foreign matter as weed seed and chaff, the elimination of small, shriveled, undeveloped kernels and injured kernels, will warrant its use. Unless the fanning mill or some other means as effective be used to clean the grain that is to be put into the ground, it will be impossible to know how much of that planted will germinate and grow. It will also be impossible to determine when sufficient seed is being sown to produce a one-hundred-per-cent stand.

The impression seems to have gained very general credence that wheat "runs out" when the same strain is kept for many years on the same farm. No doubt much of the reason for the acceptance of this theory can be found in the experience of very careless farmers who continue year after year to sow poorly selected and poorly cleaned wheat and on poorly prepared land. Such farmers fail to use the fanning mill, so with each succeeding season their seed wheat is made up more and more of light, immature kernels, and inert matter. As the years go by their land loses its fertility, and as the wheat yield grows smaller from this cause, the careless farmer assumes that something constitutional is the matter with his wheat variety. The thinner the land and the poorer the growth of wheat, the greater will be the growth of weeds; and these not being removed reduce the yield still more. Finally the careless wheat grower may be induced to buy some clean, plump, vigorous seed wheat, and, as might be expected under such circumstances, the yield is noticeably better, particularly when as is often the case the new variety is put in choice ground. It is too often assumed that such improvement has been due to the fact that the new seed came from a distance, when in most cases a similar improvement might have been made by vigorous use of the fanning mill on seed grown close at hand.

A pure variety is always to be preferred to a mixture of varieties. however slight this may be. Heavy seed promotes stooling and the production of strong plants, and benefits yield and quality of

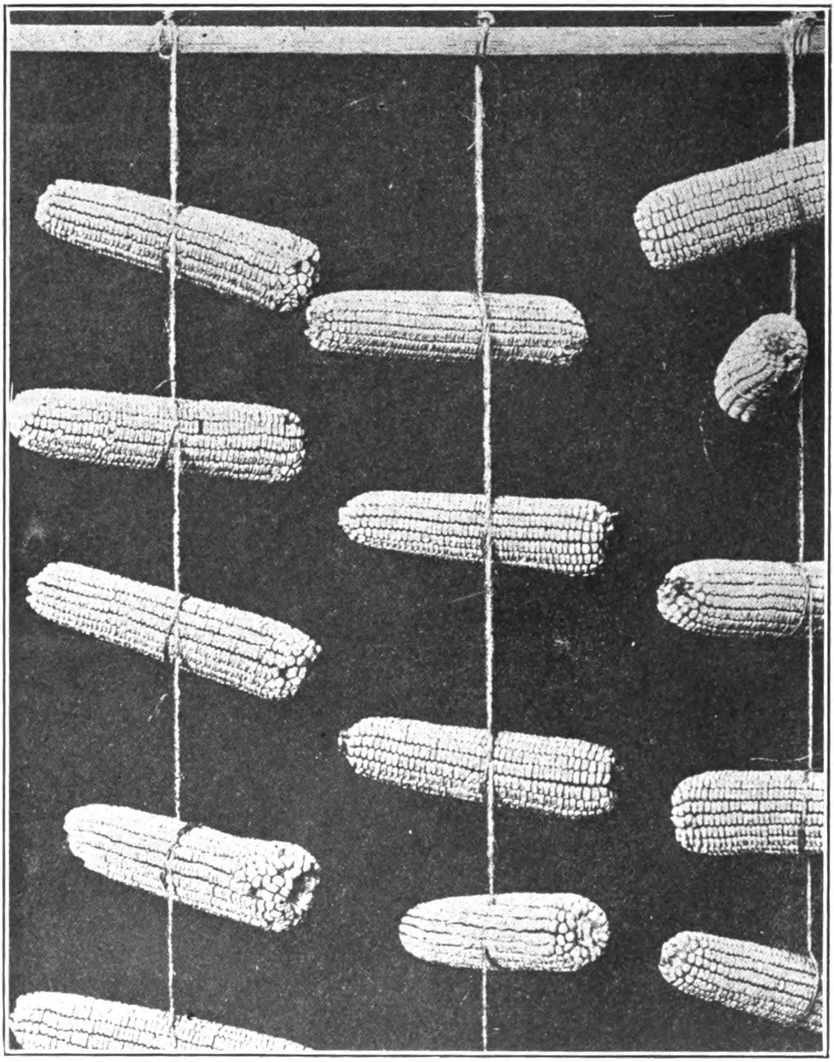
grain as well as yield of straw. In most cases where heavy seed has been compared wth small or light seed, the results have been in favor of the heavy seed. Owing to an insufficient food supply or an imperfectly developed germ, plants from injured and immature seed often have not the power to live although the seed sprouts quite successfully. If wheat has become heated or moldy in storage it may not grow at all or else have only a low percentage of germination. It is advisable, therefore, to make a germination test to determine the vitality and the viability of the seed. This may be done by placing the kernels between folds of cloth or blotting paper, one end of which is placed in water so that the moisture is supplied through capillarity, and by keeping this improvised germinator at the ordinary room temperature, never allowing it to fall below 50° F.

The time of sowing is influenced by the season, the variety, the nature, fertility, and altitude of the soil, the latitude of the locality, and sometimes by the prevalence of insect enemies and existing weather conditions. In the northern sections winter wheat is sown earlier and spring wheat later. In the southern winter wheat regions the seed is preferably sown late in September and early in October; in Ohio, Indiana, Illinois, Iowa, and Nebraska from September 10 to 20; and in some of the extreme northern winter wheat regions as early as the last week in August and the first week in September. Spring wheat is generally sown as soon in the spring as the seed bed can be properly prepared.

The germination, stooling process, and underground growth of winter wheat take place when the temperature is from 42° to 50° F. When these soil temperatures prevail during winter for a sufficient length of time, winter wheat stools and produces underground growth, and when the continued warmer weather of spring arrives the different stems shoot upward and develop their leaves and lengthen their internode rapidly.

The depth of sowing depends mainly upon the kind of soil and its physical condition. The object should always be the provision of the best moisture conditions for the seed. In moist soils or soils of a hard texture shallow seeding is practiced, while in loose or dry soils deeper seeding is necessary. The usual depth of sowing wheat is from 1 to 2 inches. When the seed kernel lies deep the portion of the young stem connecting it with the crown is necessarily longer than when it lies nearer the surface of the ground, as in the case of shallow seeding. If at any time through the action of frost, or otherwise, heaving of the surface soil occurs, the young stem may be broken so that the crown and other parts of the plant are separated from the primary root system. This condition is detrimental to the plant if it occurs before the permanent roots are large enough to furnish food and moisture as the maintenance and the growth of the plant require it.

The quantity of seed used per acre depends upon the kind of soil and its physical condition, the climate and the season, the time and method of sowing, and the size, quality, and variety of the seed.



An Ideal Method of Treating Seed Ears by Stringing Them Immediately After They Are Gathered. Dept. of Agr.

(See page 403.)

As a general rule wheat is sown thicker on poor soils, stiff and cold clay lands, and rough and cloddy seed beds than on fertile soils, friable loams, and fields well worked and smoothed before seeding. Late sowing and broadcasting also require more seed than early sowing and drilling. A large-grained variety requires a greater quantity of seed than a fine-grained sort, and a variety with limited stooling capacity more than a heavy stooling variety. Generally the quantity of seed per acre varies from 6 to 8 pecks, but in dry-land farming as a rule less is used.

There are two common methods of sowing wheat, viz., drilling and broadcasting. Different kinds of machines are used for both operations, but broadcasting is also done by hand. Drilling is done with common drills, press drills, shoe-and-chain drills, disk drills, etc. Each method has its advantages under certain conditions. The results at most of the experiment stations are in favor of drilling.

Rolling and sometimes harrowing is resorted to during the early stages of the crop. Late rolling and late harrowing are often injurious. In dry climates and seasons cultivation between the drills is sometimes carried on.

Crop Rotations.—The place of wheat in the crop rotation is largely governed by the cleanness of the soil, the adaptability of wheat as a nurse crop for clover and grass, the possibility of either fall or spring sowing, the comparatively early ripening of the crop, the fertility of the soil, and other conditions.

Hoed crops and summer fallow, especially if cultivated, tend to leave a greater quantity of water in the soil than growing broadcasted and uncultivated crops, such as the small grains. In a dry season, for this reason, wheat after corn or cultivated summer fallow is likely to give a much better yield than if grown after wheat or oats. On some new soils wheat is sometimes grown for several years in succession on the same land, but continuous cropping experiments have shown that after a series of years the yields begin to decline, and rotation experiments have clearly indicated that better yields are obtained from soils under rotation than those growing wheat year after year.

Irrigation and Rainfall.—Successful wheat culture does not depend so much upon the total annual rainfall as it does upon the amount of moisture the soil furnishes the crop during the growing period. The total rainfall in some of the wheat-growing localities of the West and Northwest ranges annually from 12 to 18 inches, which falls mainly during the winter, and yet good crops are produced without irrigation, while in other sections the same amount of rainfall is insufficient for a profitable yield. Again, in many humid regions which have a yearly precipitation of as high as 40 inches, the water runs off in the drainage, and less than half of the total precipitation is available to the growing plants. The question, therefore, is not alone how much rainfall there is, but how much of it is retained by the soil for the use of the crop. The relation of rainfall to wheat culture is largely a question of soil conditions. It is a significant fact that a very large proportion of the wheat of the

world, as well as a superior quality of grain, is produced in rather dry regions or on lands subject to extremes of temperature and drought. And it is further worthy of note that most of the States in which semiarid conditions prevail to a greater or less extent record a much higher average yield per acre than humid wheat-growing States in both spring and winter grain.

Wherever or whenever the rainfall is deficient, irrigation generally insures a crop and secures larger yields and better grain. It must be practiced judiciously, however, to be successful. Furrow irrigation is considered best in some sections and flooding in others. Irrigation sometimes has a marked influence on the composition of the grain. At the time the kernel is filling out the soil should be properly supplied with moisture to promote the production of full and plump grain. Too much water at this period has a tendency to yellow the crop, retard its maturity, and to lower the yield. Fall irrigation of winter wheat has been found beneficial when the soil lacked moisture for the production of the necessary fall growth. One or two irrigations are sufficient for winter wheat in the spring. The custom in Egypt, where irrigation is commonly practiced, is to irrigate when the plants are about 1 foot high and again when they begin to bloom. When the water is applied in the evening, about sunset, the evaporation from the surface of the soil is much less than when it is applied during the day, and it also frequently results in a higher yield of straw and grain.

Harvesting.—The time of harvesting wheat is mostly controlled by the latitude and the seasons. The world over, wheat is harvested in every month of the year. In general practice wheat is cut when the heads have turned yellow but while the stems are still slightly green and the kernel in the hard-dough stage. In the greater portion of the wheat-producing area of this country harvesting must be done in from eight to ten days to prevent losses from shattering, but varieties grown in some sections, such as the club wheats in the Pacific Coast States, may be left standing for several weeks when ripe without danger of shattering. The state of ripening influences the composition of the plant. The dry matter in the entire plant increases up to maturity and the kernel increases in starch content as it develops.

Farmers have long recognized the fact that it is better to begin cutting grain one day early rather than one day late. The machinery is not always in perfect adjustment, and at this stage of growth the ripening advances rapidly every twenty-four hours. Cutting grain at the right time is an important item in the final result. Extreme early cutting means loss from shrinking, while undue delay will result—with a possible exception of an occasional variety—in loss from shelling. After the farmer has met all the requirements for a profitable crop, it is very desirable that he select the right date for cutting.

There are various methods of harvesting and caring for the wheat crop, depending upon the section of the country in which it is grown. In the Eastern States the wheat is cut with a self-

binder and most of it is either stacked or stored in the mows of large barns. West of the Mississippi River, in the Great Plains area, both self-binders and headers are used, and only a comparatively small portion of the wheat cut with the binder is stacked, the larger portion being thrashed direct from the shock.

The header is used most in the western portions of the Dakotas, Nebraska, and Kansas, but the relative quantity cut in this way depends much upon the season. It is usual to start with the binder, and if the season is such that the grain ripens rather slowly, the header is used but little. On the other hand, if the ripening process goes on rapidly and the weather remains dry, headers are used, because more acres can be harvested in the same length of time. In the latter case the grain is stacked as soon as it is cut.

On the Pacific coast and in the extreme Northwest the combined harvester and thrasher is used quite generally. By this method the grain is cut, thrashed, and sacked in one operation. Dry weather nearly always prevails throughout this section during the harvest season, and little injury results from exposure to weather. Each of these methods has its advantages and its disadvantages, but many of the disadvantages grow out of the abuse of the method.

Effect of Methods of Harvesting.—Owing to the fact that such a large proportion of the wheat of the United States is produced in the area lying between the Mississippi River and the Rocky Mountains, commonly referred to as the Great Plains area, a very large percentage of the total crop is, by reason of the methods of handling, exposed for a considerable time to weather conditions which cause it to deteriorate.

The man who will take proper precautions with soil and seed is also more likely to take proper care of his crop after maturity. It can not be denied that many a farmer's crop of wheat is allowed to be practically ruined for flour-making purposes after a very good quality of grain has matured in the field. Sometimes this is unavoidable, but more often it is the result of carelessness. Many times it happens because the farmer does not realize that these unfavorable weather conditions materially injure the quality of his wheat. Much of the wheat in Texas, Oklahoma, Kansas, Nebraska, Minnesota, and the Dakotas is not even carefully shocked, the shocks being set up carelessly and not protected at all by cap bundles. This is especially true of the larger fields in the western portions of these States.

This exposure to the effect of alternating rain and hot sun causes the kernels to swell and the branny coats to loosen, destroying the natural color or "bloom" and giving them what is termed a "bleached" appearance. Even when well shocked and protected by a cap bundle, continued exposure brings on a change in the outer bundles, which are only poorly protected at best, and after a shock has stood a month, or even less, it is found that as a result of this weather damage samples of wheat taken from the outer portions of the shock are at least a grade poorer than those taken from the inner part of the same shock. In thrashing, this poor wheat is

mixed with the good and the grade of the whole is lowered. Such exposure and the resulting change in appearance have a direct and immediate effect upon the market value of the grain. The grade that is given to wheat upon the terminal markets depends to-day almost wholly upon its appearance, condition, and test weight per measured bushel. When the natural color or "bloom" of the kernel has been destroyed by rain and sun while standing in the shock and the increase in moisture content has caused a corresponding decrease in the test weight per bushel, the grade given is lower than it would be if this same wheat were marketed in good condition without deterioration resulting from exposure to the weather. It is common knowledge among farmers that wheat standing in the shock may readily lose a pound per bushel in test weight on being exposed to a heavy shower. This is especially true where the wheat has been carelessly shocked and is not protected by cap bundles.

Effect of Exposure to Weather.—In addition to causing the bleached appearance and lowering the test weight, the exposure of wheat to rain and sun while standing in the shock causes many of the kernels to sprout, and sprouted wheat will not produce good, sound flour. Furthermore, the indications are that this excess moisture acquired by exposure in the field after harvest continues to be a source of injury to the quality until the wheat is dried either artificially or by natural means.

Sweat in Wheat.—Millers, as well as operators of country and terminal elevators, prefer wheat that has gone through the sweat. The millers invariably hold that sweating in the stack improves weathered grain and is much to be desired. Comparatively little is known as to what the process commonly referred to as sweat of wheat consists of. Very little information concerning it can be gleaned from scientific literature. The following has been advanced as a possible explanation of the change that takes place during the process. It is known that even after wheat is cut the straw contains sufficient plant food to keep the kernels in a growing condition for some time, and a chemical or enzymic action within the plant by means of which this nutriment is transferred to the grain and stored as starch may continue for a considerable period. When wheat has been thrashed before going through the sweat, it is probable that a rearrangement of the chemical constituents of the kernels still takes place, and this will account for the sweating of shock-thrashed grain in the bin.

As chemical action is generally accompanied by the evolution of heat, this may account for the heat usually generated during the sweating process. The amount of heat generated appears to be influenced by the percentage of moisture present. Grain that has been sufficiently ripened and is also very dry will give little evidence through change in temperature that it is going through the sweating process. On the other hand, wheat cut in the hard-dough stage, or containing considerable moisture, goes into the sweat much more quickly when stacked; the straw becomes very tough and a great deal of heat is evolved. Care should be exercised not to stack

wheat of this character before it is allowed to cure out in the shock for a few days; otherwise sufficient heat may be evolved, even in the stack, to injure the grain, in which case "stack-burnt" wheat will result.

Cutting the grain seems to act as a sort of check upon this biological action, and it appears to remain in a dormant state until the assembling of the grain in large bulk brings on a condition favorable to activity. When the grain is stacked the straw permits to a limited extent the circulation of air through the stack, and this circulation affords a means of conducting away considerable of the heat generated in stacked grain.

Heat-Damaged or Bin-Burnt Wheat.—If wheat with a rather high moisture content is placed, before going through the sweat, in a large bulk in a bin there is very little chance for circulation of air, and any heat generated by biological action is retained in the grain until finally the temperature becomes so high as to cause other chemical changes within the kernels; the result is what is commonly known to the grain trade as heat-damaged or "bin-burnt" wheat. This injury may extend simply into the branny coats and produce slightly heat-damaged or "bran-burnt" wheat, or it may extend throughout the endosperm and produce badly heat-damaged or "bin-burnt" kernels. Wheat in this last condition is practically unfit for flour-making purposes.

Effect of Sweating in Stack.—In order to make a preliminary test regarding the validity of the practically unanimous opinion among farmers and millers that wheat which had been bleached in the shock was improved in color and test weight per bushel upon being stacked and allowed to go through the sweat in the stack, and also to discover what effect this sweating process in the stack would have upon the market grade and the milling and baking value of the wheat, arrangements were made during the harvest of 1909 to secure from a 12-acre field of Fife wheat near Fargo, N. Dak., a load of bundles taken from the shock after they had been exposed to at least two heavy rains. This load was thrashed and the wheat stored in a small elevator bin. The remainder of the field was stacked and after standing in the stack six weeks was thrashed. Fifty bushels of the stacked wheat, taken from the same portion of the field as the before-mentioned load of shocked bundles, was placed in another small bin in the same elevator for comparison with the shock-thrashed wheat.

The shock-thrashed sample as it came direct from the thrashing machine contained 14.8 per cent of moisture, and the test weight per bushel was 55.5 pounds. The grain felt damp and tough and would scarcely have been considered in safe condition for shipment to market.

Added Advantages Derived from Stacking Wheat.—The farmer who properly stacks his wheat secures it against further loss from exposure to weather, while the one who allows his grain to stand in the shock from three to six weeks, waiting for the thrasher, runs

the risk of having it deteriorate in quality from No. 1 or No. 2 to No. 4 or even "no grade."

Another gain which may result from properly stacking the wheat is that it will come out of the stack dry and thrash out clean from chaff, thus preventing the loss sustained when thrashing bundles that are damp and tough from rain or dew. With the bundles in this damp condition, considerable wheat remains in the heads or is blown over as "whitecaps" and goes to the straw pile. This is usually a total loss, as much of the straw in the Great Plains area is burned.

Improvement in the quality and condition of the wheat is not the only benefit derived from stacking the crop. In addition to making the crop safe should several heavy rains come after harvest, which would prevent thrashing and cause rapid deterioration, the stack-thrashed grain can be placed in tight bins and kept, or it can be shipped direct to market without imminent danger of heating and spoiling in transit. Also, the shocks are removed from the field, so that plowing may be begun at once, and all good farmers readily agree that such early plowing is productive of good results in the next year's crop.

WINTER WHEAT IN WESTERN SOUTH DAKOTA.

The value of winter wheat as a dry-land crop in western South Dakota has been the subject of much discussion during the past few years. The production of winter wheat in this area has not reached the proportions of commercial importance. The advantages in favor of winter wheat, where it can be successfully grown, are better distribution of labor by fall seeding and early harvest; early maturity, and therefore less danger from hail, hot winds, disease, etc.; greater drought resistance; and larger yields. Its importance as a dry-land crop is due largely to its early maturity and to its ability to produce a fair yield even in seasons of severe drought. Winter wheat has been grown at several points in western South Dakota, in some instances for a number of years. While not uniformly successful, the crop promises good results when properly handled.

Winterkilling is the injury most commonly feared in growing winter wheat and is the principal limiting factor in the northward extension of the winter-wheat belt. It is due to extreme cold, to exposure and injury of the roots by the heaving of the soil, and to other causes. The extent of injury differs widely with the different varieties grown and is affected to a less extent by the preparation of the soil and seed and by the time, rate, and method of seeding.

Damage from the blowing of the soil in high winds is an important consideration on the dry lands. The danger is greatest on soils containing sand or fine gravel and in fields fully exposed to the wind. In the late winter and early spring months, the velocity of the wind is often great enough to carry the soil particles rapidly across the field, cutting off the plants near the ground and exposing the roots to the weather. This condition is especially trying on dry farms, as dry winters are common and the plants and soil are left in

a condition most favorable to rapid evaporation. Undoubtedly much of the loss ascribed to winterkilling may be traced to this cause.

The extent of injury likely to be done is affected by the location of the field, ridges being exposed to and valleys or swales being more or less protected from the full violence of the wind. Consequently fields partly protected are less likely to be damaged than are those fully exposed to the prevailing northwest winds.

Little progress has been made in devising methods of handling cultivated fields to prevent blowing. The problem is especially difficult for the dry-land farmer, as the fine soil mulch, which is so necessary to conserve moisture, increases the danger from blowing. It is necessary, as far as possible, to choose some middle courses which will involve the least loss of moisture and at the same time minimize this danger. Implements with cutting blades that fine the soil out of all proportion to the value of the work done should not be used. The disk and spring-tooth harrow are preferable, as they tend to bring the larger particles and lumps of dirt to the surface and allow the finer particles to reach lower levels of the soil stratum.

It is important that some method of crop rotation be followed that will supply humus to the soil, as possibly no other factor is so efficient in cementing the soil particles together and preventing blowing.

Preparation of the Soil.—Several methods of preparing the soil for winter wheat have been advocated, such as seeding in small-grain stubble without previous preparation; seeding on corn ground between the standing rows with a 1-horse drill; seeding on corn ground after preparing with a disk and harrow; seeding on early fall plowing; and seeding on land prepared by summer-fallowing.

The first two methods are employed to catch and hold the snow and thus prevent winterkilling. The average snowfall in western South Dakota is rather light and the snow seldom stays on the ground during the entire winter. For this reason the benefit likely to be derived is not so great as in sections where the snowfall is heavier. On the other hand, there is apparently not as much danger from alternate thawing and freezing as in sections where there is more moisture, so that protection is not so necessary.

Possibly the chief difficulty likely to be encountered in growing this crop on any but summer-tilled land is to conserve sufficient moisture in the soil to germinate the grain and properly maintain its growth until the spring rains begin. The same difficulty also applies to summer fallow not properly cultivated or when the rainfall is so deficient that no moisture can be stored in the soil. The autumn precipitation is usually very light and so distributed that it is often insufficient to start the crop. It frequently happens that there is sufficient moisture to germinate the grain but not enough to maintain its growth, in which case it may be greatly injured or killed by continued drought. On the other hand summer tillage is likely to increase the danger from blowing, as the tilth necessary

to conserve the moisture leaves the soil in such a condition that it is easily carried away by the wind.

When heavy rains occur in the late summer and early autumn months, it may be found advisable to increase the winter-wheat acreage by seeding on corn ground or on early fall plowing. The former is probably preferable. In either case there should be sufficient moisture in the soil to keep the crop in good condition until spring. Otherwise, the plants may die or go into the winter in a weakened condition.

A good summer fallow consists essentially in early plowing and sufficient cultivation afterwards to conserve the moisture. A good plan is to plow in the spring as soon as possible after seeding, or earlier if desired. The ground may then be worked at once with disk and harrow, or it may be allowed to remain as left by the plow in the expectation of heavy rains in May and June. The method to be followed depends upon the quantity of moisture in the soil at the time of plowing. In either case cultivation should follow every rain sufficiently heavy to connect with the moisture below or to supply more moisture to the soil than will be lost by the cultivation. A practice sometimes advocated is that of plowing in the fall soon after the crop is removed and allowing the ground to remain rough until spring, when it is cultivated as in the former case.

Seeding.—The growing of varieties not adapted to the locality is a great drawback to the success of a crop. This fact has been clearly demonstrated by experiments conducted on the Great Plains and by the experience of farmers. The Turkey and Kharkof varieties have great ability to recover after a hard winter. When damaged, good judgment should be exercised before reseeding to spring grain.

If a good seed bed is prepared and there is sufficient moisture present to germinate the grain and keep it growing vigorously, early seeding is advisable, as the temperature at an earlier date is likely to be more favorable to germination and rapid growth. It is not advisable, however, to seed on poorly prepared soil simply for the sake of seeding early, when a few days' delay would permit the preparation of a good seed bed. On the other hand, it is not well to put off seeding until very late, as there is grave danger that the seed will never come up. It is essential that the seed be placed in close contact with soil containing moisture. To insure this it is best to seed with a drill, as by so doing the seed can be placed at the desired depth and the soil packed around it. By drilling, a more uniform stand is obtained and a smaller quantity of seed is required than by seeding broadcast.

The exceptional stooling of winter wheat makes it unnecessary and inadvisable to seed this grain as heavily as spring wheat. The usual rate recommended for semiarid conditions is about 3 pecks per acre, a less quantity sometimes being advocated. With a well-prepared seed bed this amount is probably sufficient for western South Dakota conditions. Unless damaged by winterkilling or other causes, winter wheat is more likely to be too thick than too

thin at harvest time. While a very thick stand may slightly increase the yield in a favorable year, it may greatly decrease it in an unfavorable one.—(B. P. I. Cir. 79, 1911.)

WHEAT GROWING ON THE PACIFIC COAST.

The Pacific coast wheat region embraces all of the wheat-producing lands of California, Oregon, and Washington, and the northern portion of Idaho, which is practically a continuation of the great Palouse Valley. Methods employed in cultivating and harvesting wheat in this section are radically different from those in any other section of the country; in fact, even different sections of the Pacific coast region have entirely different methods both of tilling the soil and harvesting the crop.

Varieties of Wheat Raised.—The varieties of wheat sown in this section are also entirely different from those of any other section of the country, their peculiar characteristic being a white grain, with a soft and starchy content; and conditions of soil and climate are such that even other wheats when imported for seed, although when originally planted entirely different in character from those of native growth, lose their individuality in a season or two and come to have practically all the characteristics of the standard soft white wheats of this region.

Introductions of other varieties, hard red wheat in particular, and in fact almost all of the hard wheat varieties, have been tried in this section, but it has been found that as soon as they become acclimated they partake largely of the characteristics of the native wheat of this section. The principal factor in producing grain of such character is probably the lack of humus in the soil, aided, no doubt, by the generally cool summers of this region.

A large proportion of the more common varieties peculiar to this region are of the Club Wheat group, so called on account of the peculiar club-like formation of the head. In California, Defiance and White Australian wheat are grown almost exclusively for milling purposes, and Sonora wheat for shipping. Red Chaff and Foise are the principal varieties grown in Oregon, and Palouse Blue Stem in Washington and Idaho. The ability of Club wheats to hold the grain and prevent shelling makes them especially desirable in this region of exceedingly dry summers, where the grain, after becoming fully ripe, is frequently left standing in the field for thirty to sixty days before being harvested.

Seed Requirements.—The amount of wheat required for seed varies greatly in different sections of the country, and there is also considerable variation in the time of sowing, winter wheat being sown from September to the middle of January, and spring wheat often as late as March 15. Late-sown wheat requires a very much larger amount of seed per acre than that sown earlier in the season, so that it not infrequently occurs that the sowing on farms in the same immediate locality will vary from 30 to 100 pounds per acre, and this great variation has rendered it practically impossible to make an accurate calculation of the amount of wheat sown per acre for the entire region; but it is probably somewhere near 70 pounds.

This would indicate a total seed requirement of about 5,000,000 bushels, of which California uses a little more than 3,000,000 bushels, Oregon nearly 1,000,000, Washington about 820,000, and Idaho 121,000 bushels.

Summer Fallowing.—Summer fallowing is generally practiced all over the entire region, largely owing to the fact that there is practically no rotation feasible. On a considerable portion of the area devoted to wheat in this section it is also impossible to grow a fertilizing crop to plow into the ground, as is the custom in the more humid sections of the country, as there is barely sufficient moisture for the staple crop.

The soil on the summer-fallowed land derives great benefit from the disintegration of its otherwise insoluble ingredients by the action of the air; but the chief benefit derived is from the rain of two seasons falling on the land on which one crop is to be produced. The greater portion of the wheat land of this region is capable of absorbing all the rain that falls, and the maintenance of a loose, clean surface as presented by the summer fallow prevents evaporation. In addition to this, early sowing gives the land a long growing season, with the result that a good crop is nearly always raised on land which has been treated in this manner, even though the rainfall during the growing season is scant.

Summer-fallowed land is frequently sown in May of the season following its period of idleness; where pasture is needed, the cattle are allowed to graze on the young wheat during the entire summer season, and in the fall the final growth of wheat is allowed to start. Probably half the wheat land of the entire Pacific coast region is summer fallowed each year. This gives one crop on an average every two years, but if a sufficient amount of rain falls immediately after harvest it is possible to raise two crops in three years by reseeding promptly. No fertilization of the wheat fields other than by summer fallow has been attempted except by individual farmers or in an experimental way by the State bureaus and experiment stations.

THE MILLING QUALITIES OF WHEAT.

The value of the wheat to the producer is determined by its ability to yield profitable returns for the expense of producing it. One factor in determining this is the price per bushel which the consumer of the wheat pays him for it. The price which the consumer can pay is in part controlled by the food value of the grain and its products. It is this food value which is meant by the expression "quality of grain." It would seem at first thought, therefore, that the quality of the wheat would be determined by a simple estimate of the amount of each of the several food principles which it contains. This is not the case, however, since practically the entire class of consumers of wheat use it not as wheat but as bread. Before it can be consumed as bread it must first be milled into flour, and the practical value of the wheat to the consumer lies chiefly in the flour which it will produce. The measure of the value of the wheat is, therefore, in its milling qualities. The question for con-

sideration is, then what are the factors which influence, or determine, the milling qualities of wheat.

The first factor in determining the milling quality of wheat is the chemical composition of the wheat itself. For the purposes of chemical analyses, and to aid in estimating the food value of the material, the constituents of grains are commonly divided into five groups, or classes; namely, moisture, ash, crude protein, fats, carbohydrates. These are not five separate and distinct bodies or things, but are groups of substances having very similar properties and food values Thus, for example, crude protein is the name for a general class of nitrogenous bodies, of which the albumen or white of eggs, the mucin or lean meat of animal bodies, the gluten of flour, etc., are common examples. Again, carbohydrates is a general term including a large number of substances, such as starches, sugars, certain vegetable gums, and the like. Now, since it is the substances belonging to the protein group in the wheat which gives rise to the gluten in the flour, and the carbohydrates of the wheat which yield the starch of the flour, it is obvious that the percentages of these constituents in the wheat is one of the determining factors in its milling qualities.

The percentages of the constituents may vary greatly in any given breed or variety of wheat. It is believed that variations are due to differences in the length of ripening period of the grain. Most authorities are now fairly well agreed that the ripening of grain is merely a process of desiccation or "drying up." Hence, conditions favorable to rapid drying produce rapid ripening and harder grain. The one climatic factor which would, therefore, have the chief influence in changing the composition or type of grain is that known as "evaporation-coefficient." Several factors or conditions cause changes in the rate of evaporation of water at any given time or place, such as temperature, relative humidity of the air, wind velocity, etc., etc., but the combination of these is without doubt the influence which is the chief determining factor in the rapidity of ripening of the grain and this, in turn, determines the "hardness" or type of wheat.

The second factor influencing the milling quality of wheat is the percentage of each of the several mill products which it will yield. While each of these products, namely, bran, shorts, middlings, and the several grades of flour, has a considerable food value, and a definite market price, the flour is the product which commands the highest price. Therefore, the greater the yield of flour per given weight of grain, the larger will be the money return for it. This factor, however, is too well known and too generally recognized to need further discussion.

The third factor is the distribution of the valuable constituents of the wheat to the several mill-products. Wheat of high milling quality must not only possess large amounts of the desirable chemical constituents, but they must be so distributed in the grain that they will appear chiefly in the flour when the grain is milled. If they go elsewhere, into the bran for example, the latter will have a

resulting higher feeding value; but this is not desirable in milling wheat, where the flour is the critical product in determining the value of the manufactured product.

Fourth, the quality of the flour. This is the dominant factor in determining the real milling value of the wheat. Wheat flour is distinguished from the meals of all other grains by its ability to produce "light bread." Other meals, such as corn-meal, oat-meal, etc., often contain as much, or possibly more, total food materials or nutriment, as does wheat flour, but they will not produce "light bread." "Lightness" is due to imprisoned gas, generated by the fermentation of starch by yeast, or produced by baking powders. This same fermentation of starch, liberating bubbles of carbonic acid gas, may be caused by yeast acting on starch in corn-meal, but the corn-meal dough will not become "light" because there is nothing there to imprison them. The substance which is peculiar to wheat flour is this tenacious, elastic material, called gluten, which serves to retain these gas bubbles in the dough during baking. Gluten is not the only valuable ingredient in wheat flour. Starch is just as necessary an ingredient and possibly of even greater food value. But starch can be grown and supplied by many other plants just as easily, and perhaps more cheaply than by wheat. If it were possible to grow a wheat so rich in protein that it would yield flour containing too small a proportion of starch for proper baking qualities, this deficiency could easily be overcome by adding starch from some other source. But if, as is often the case, a given wheat is too rich in starch and produces flour yielding too small amounts of gluten, there is no other possible source to get gluten with which to build up this lack and the flour must be poor in baking qualities. Hence it is that the amount of gluten yielded by the flour is properly taken as the measure of the value of the wheat for milling purposes. But it is not alone the quantity of gluten produced which measures the value of the flour for baking purposes. The quality of the gluten must be taken into consideration as well. As will be more fully described in the section on baking tests in this bulletin, gluten is made up of a mixture of two proteid bodies of very different properties, and the quality of the gluten depends very largely upon the proportion of these two which is present in the flour. The quality of the gluten from two different samples of wheat may be very different even though its quantity may be the same. Hence a determination of the total amount of gluten yielded by a sample of flour must be supplemented by certain tests as to its quality before a true judgment as to the quality of the flour can be passed.

The fifth and final factor in determining the milling value of wheat is the color of the flour which it will yield. This is a matter of prejudice alone, on the part of the consumer, and is in part controlled by the system of milling employed. Hence, while color is still a factor of some importance in determining the preference of purchasers for certain grades of flour, it is of minor importance in a scientific investigation of the milling values of our wheats.

Wheat References.—B. P. I. Cir. 68, 79, 178; Div. Statistics Miscl. Bul. 20; Y. B. 1901; Farmers' Institute Lectures No. 11, 1910; Div. Botany, 231; Tuskegee Nor. & Ind. Inst. E. S. 8; Ark. A. E. S. 42, 53, 62; Ga. A. E. S. 44; U. Ill. A. E. S. Cir. 99, 1905, Bul. 22, 41, 121; Purdue U. A. E. S. Cir. 23, 1911, Bul. 41, 45, 51, 56, 61, 72, 114, 117, 139, 149; Iowa Ag. Col. E. S. 45, 51, 55; Kans. St. Ag. Col. E. S. Cir. 3, 1909, 11, 1910, Bul. 11, 20, 33, 40, 47, 59, 71, 144, 156, 167, 170, 176, 177, 178; Ky. A. E. S. 113, 115, 135; Md. Ag. E. S. 147; Mich. Ag. Col. E. S. 28, 38; U. Minn. E. S. 11, 27, 29, 62, 63, 68, 70, 85, 90, 111; Mo. Ag. Col. E. S. 15, 21, Cir. 43, 1910; Montana A. E. S. 84; U. Nebr. A. E. S. 89; Nevada St. U. A. E. S. 30; N. H. A. E. S. 145; N. Mex. A. E. S. 8; N. C. A. E. S. 91; N. Dak. A. E. S. 8, 9, 15, 17, 38, 43, 72, 75; Ohio A. E. S. Cir. 84, 1908, Bul. 118, 129, 163, 165, 221, 231; Okla. A. E. S. 47, 65; Pa. St. Col. A. E. S. 39, 46, 48, 55, 67, 82; S. C. A. E. S. 7, 37; S. Dak. 92; U. Tenn. A. E. S. 2, 1900, 2, 1901; Utah A. E. S. 56, 103; Wash. St. Col. A. E. S. 84, 89, 91, 100, 102, Cir. 8, 1908, 21, 1909, 29, 1910, 39, 1911; Wyo. A. E. S. Rpt. 1900. The above authorities were consulted and extracts were made from nearly all; the whole article on wheat was taken literally from these documents.

OATS.

Their Importance.—The production of oats is confined to the Temperate Zones. The crop does best in cool climates and will not thrive in the warmer regions unless the water supply is ample. It reaches its best development in Norway, Sweden, Germany, Great Britain, and Canada, and in the United States in Washington, Idaho, and Montana. Good spring oats are seldom produced in the southern part of the United States or in southern Europe, while the northern limit of production is near the Arctic Circle, in Norway and Alaska. The crop is very generally grown in the central and northern portions of the North Temperate Zone. The world production of oats in bushels is greater than that of either corn or wheat, but as its weight per bushel is much less, the total production in pounds is smaller than that of either of those crops. The greater portion of the oat crop of the United States is fed on the farms where it is grown.

Chemical Analyses.—The chemical composition of oats, oat straw, oat hay, and the green plant, together with similar analyses of other grains for comparison is shown in the following table:

Results of analyses of oats and of oat products, showing the percentage of water and the number of pounds of ash, protein, etc., in 100 pounds of water-free substance, with similar figures for other grains for comparison.

Feed.	Samples.	Water.	Constituents in 100 pounds of dry matter.				
			Ash.	Protein.	Fiber.	Carbohydrates.	Fat.
Grain:	*Number.*	*Per cent.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Oats	30	11.0	3.3	13.3	10.7	67.1	5.6
Wheat	310	10.5	2.0	13.4	2.0	80.3	2.3
Barley	10	10.9	2.7	14.0	8.0	78.3	2.0
Corn	208	10.9	1.7	11.8	2.3	78.1	6.1
Oat products:							
Oat shorts	2	5.4	3.8	19.1	5.7	65.4	6.0
Oat bran	2	6.1	6.7	13.0	19.8	56.3	4.2
Oat dust	2	6.5	7.4	14.4	19.5	53.6	5.1
Oat kernels	6	7.9	2.2	16.0	1.0	73.1	7.7
Oat hulls	1	7.3	7.2	3.6	32.0	56.1	1.1
Straw:							
Oat straw	12	9.2	5.6	4.4	40.8	46.7	2.5
Wheat straw	7	9.6	4.7	3.8	42.1	48.0	1.4
Barley straw	97	14.7	6.7	4.1	42.0	45.5	1.7
Rye straw	7	7.1	3.4	3.2	41.9	50.2	1.3
Corn stover	60	40.5	5.7	6.4	33.1	53.0	1.8
Hay:							
Oat hay	12	16.0	7.3	8.8	32.4	48.3	3.2
Oat and pea hay	4	9.8	8.8	11.4	32.7	44.4	2.7
Barley hay	4	10.6	5.9	10.4	26.4	54.5	2.8
Timothy hay	68	13.2	5.1	6.8	33.4	51.8	2.9
Green fodder:							
Oat fodder	6	62.2	6.5	8.9	29.6	51.0	4.0
Corn fodder	126	79.3	5.8	8.7	24.2	58.9	2.4
Rye fodder	7	76.6	7.7	11.1	49.6	29.1	2.5
Red clover	43	70.8	7.2	15.1	27.7	46.2	3.8

In above table the chemical composition of oats is shown in comparison with that of wheat, barley, and corn. The figures show that while oats are higher in crude fiber, due to the hull, the grain contains a high proportion of protein and fat, two very valuable constituents. Although practically one-third of the grain is hull, oats contain as much protein as wheat, nearly as much as barley, and more than corn. They are much higher in fat than either barley or wheat and are higher in ash or mineral matter than any of the other grains. As protein is a flesh-forming element and ash is used in the formation of bones, it can readily be seen why oats are so valuable for feeding to young and growing animals. The percentage of water as given for the different grains is that found in laboratory samples; ordinary commercial samples of all grains usually show a higher moisture content.

The table also gives the chemical composition of oat hulls and oat kernels and of several products of the oatmeal industry. While these oat feeds are not well known, their high feeding value, as shown, indicates that they should be used wherever they are obtainable at a reasonable price. There is considerable variation in the composition of different varieties of oats and of different samples of the same variety, largely due to differences in the percentage of hull.

The analyses of oat straw show that this roughage well deserves its reputation as the best of its class for feeding. In protein and fat

it is higher in feeding value than wheat, barley, or rye straw, while in carbohydrates there is little difference. Pound for pound in its natural condition it is also materially better than corn stover, on account of the greater moisture content of the latter, but the dry matter in corn stover is rather richer in food constituents than that in oat straw.

Oat hay is shown to be slightly inferior to barley hay in feeding value, but it ranks higher than timothy hay in protein and fat, and in consequence is a slightly better feed. Hay made from the bearded varieties of barley is sometimes not readily eaten by stock on account of the beards; the waste thus occasioned makes oat hay fully as valuable, ton for ton, as hay made from bearded barley. The composition of several samples of hay made from oats and peas is also shown in the table. While the composition of this hay depends to some extent on the proportion of the two crops in the mixture, its high feeding value is apparent.

The crop cut green for feeding contains less water than either corn or rye. The superiority of oats over rye for soiling is particularly noticeable, as the oats are much higher in total food value. Green oats compare quite favorably, pound for pound, with green clover.

Use of Oats as Human Food.—Oats have been used as human food in northern Europe for many centuries. In Scotland oatmeal porridge, or groats, is one of the principal articles of diet. Hulless oats are largely used as food in the mountainous districts of China, where the grain is not only used as porridge but is ground into meal and used in the making of bread and cakes. In the United States the manufacture and consumption of oatmeal have greatly increased in recent years. Most of the oatmeal now manufactured is more properly termed "rolled oats," though the cracked or cut grain, commonly known as "groats," is used to a limited extent.

Oatmeal when properly cooked is one of the cheapest and best of the cereal foods. Long cooking not only makes it more palatable, but greatly increases its digestibility. The Iowa Agricultural Experiment Station found that the average price per pound of three brands of oatmeal were slightly less than that of seven uncooked foods made from other cereals and little more than half that of seventeen brands of prepared cereals. Ten cents purchased a greater fuel value in the form of oatmeal than in the average of the other uncooked cereals, and nearly double that which could be obtained in the prepared cereals. The protein content of the oatmeal was greater than that of any of the other cereal foods. It is generally recognized that most of the protein in oatmeal is readily digestible and that oatmeal is a valuable addition to the diet.

Feeding the Grain to Stock.—Oats have long been the staple grain for feeding horses. The high protein content furnishes a large amount of muscle-building material for the development of young animals and for the maintenance in good condition of older ones at heavy work. The protein and fat in the grain are largely

digestible, while complete mastication and digestion are aided by the presence of a considerable amount of crude fiber in the hull.

Probably by far the greater portion of the oats produced in the United States is fed to horses. In the opinion of many good horsemen no other feed produces as good results in keeping the animals in good condition and high spirits. Though the stimulating effect of oats on horses is generally recognized by horsemen, the attempts of chemists to find the active principle which produces it have been without results. Recent experiments with other feeds for work horses indicate that equally as good results can be secured where oats are in part replaced by corn, especially if a small amount of oil meal or other feed rich in protein is also used.

Oats are usually fed whole to horses. In the feeding of young colts and older animals with poor teeth, grinding or crushing the grain is of benefit. Musty grain should never be fed to stock. New oats should be fed with caution, as they are likely to have a decidedly loosening effect on the bowels.

The high protein content and readily digestible nature of oats make them excellent feed for dairy cows. Often, however, they are too high in price to feed with profit. According to a test conducted by the Wisconsin station, oats, pound for pound, are somewhat more valuable than bran for milk production. On this basis, with bran at $25 a ton, oats are worth 44 cents a bushel for dairy cows. The grain is usually fed whole, though it is sometimes crushed or ground or fed in the form of corn and oat feeds. Some of the prepared feeds bearing this name, however, contain a large percentage of oat hulls and little of the grain. Oats are excellent for feeding to calves, particularly to those of the dairy breeds. They seldom form an important part of the ration of fattening cattle.

Oats are valuable for feeding to sheep, particularly to growing lambs and to ewes. While experiments show that this grain is only a little lower in feeding value than corn for fattening sheep, better results will be secured by feeding corn and oats mixed than oats alone. Oats are usually fed unground. Breeding ewes should be fed a half pound of oats, bran, or peas daily, the selection of the grain depending on the availability and the relative prices of the different feeds. Sheaf oats make good feed for sheep as well as for other stock. Ground oats can be fed to young lambs with excellent results.

On account of the large quantity of crude fiber in oats, this grain is not well adapted for use in feeding hogs. An experiment at the Wisconsin station showed excellent results when a ration of one-third ground oats and two-thirds corn meal was fed to growing pigs. A larger proportion of ground oats or the substitution of whole oats for the ground oats decreased the rate of gain and increased the cost. Ground or crushed oats are excellent for brood sows. They can be fed with best results in the form of slop, alone or in combination with bran, shorts, or peas.

Oats are quite largely used in poultry feeding, forming an important part of the grain ration of breeding stock. They are usually

Loose Smut of Wheat, Various Stages.

valuable grain to combine with corn to balance the ration. They are little used for fattening poultry.

Use as By-Products.—As the principal aticle manufactured from oats is oatmeal, so the principal by-products of oatmeal manufacture are oat feeds. If these feeds contain a considerable proportion of small oats and broken kernels they may form a valuable addition to the ration. If, however, they are made up largely of oat hulls, as is often the case, they have about the same value as other coarse roughage and can not be considered as a concentrate. The corn and oat feeds on the market are usually made up of cracked corn and the refuse from oatmeal mills, which, as just stated, often consists largely of oat hulls. Their feeding value does not ordinarily justify the high prices at which they are usually sold.

Utilization of the Straw.—Oat straw is quite largely used for feeding to horses, cattle, and sheep. As a part of a maintenance ration, it is of considerable value, being nearly equal to corn stover (the stalks with the ears removed). If the straw is of good quality there will be less waste in feeding than with stover. It is higher in feeding value and more palatable than the straw from any other small grain. A common practice in feeding oat straw is to allow the animals to run to the stack at will. This is wasteful when roughage is high in price, as much of the straw will be trampled under foot and worked into the manure. A better plan is to feed the straw from mangers or open racks, as there is much less waste from feeding in this way. If roughage is low in price and straw is plentiful, however, the extra expense of hauling the straw to the racks will not be justified.

Where it is not utilized for feeding, oat straw is largely used for bedding for animals and in the formation of manure. When combined with the droppings from animals, it serves to hold the liquid manure, gives bulk, and adds humus and considerable fertilizing material to the soil. At the present prices of commercial fertilizers, $3 a ton is a conservative estimate of the value of oat straw as a fertilizer. It is altogether too valuable to burn, a common practice in some sections. Oat straw is not extensively used in manufacturing, rye, wheat, and rice straw being the kinds that are commonly utilized.

Use as Hay and Pasture and for Soiling.—A considerable acreage of oats, either alone or in combination with peas or vetch, is harvested annually for hay. Oat hay is produced to some extent in the South, particularly in those sections where the crop does not produce grain satisfactorily, and in the Pacific Coast States. With Canadian field peas, oats are grown for hay in the northern portion of the United States and in Canada, while this crop is grown with vetch in the Pacific Northwest and in a very limited way in the South. If cut when the grain is in the milk, oats make a very palatable and nutritious hay, which is readily eaten by stock of all kinds. The addition of peas or vetch increases the yield of hay as well as its feeding value. Hay from oats alone or from oats and peas is cut and cured like other hay, though if the crop is heavy it may be

found rather difficult to cure. Curing in the windrow or cock, with as little handling as possible, is desirable in order to retain the leaves and pods on the pea vines. The hay should be cut before many of the pods ripen; otherwise the peas will shell out in handling and a valuable portion of the crop will be lost. The grain binder may be used in harvesting if the crop is allowed to become nearly ripe before cutting and is partially cured before shocking. A good crop of oats should yield from 2 to 2½ tons of cured hay, while peas and oats together should make from 2½ to 3 tons.

Oats alone or in combination with either peas or vetch make an early, nutritious, and heavy-yielding soiling crop. If several seedings are made in succession at intervals of a week or two, the crop is in good condition for use over a considerable period. If more is grown than can be used for feeding green, the crop may be allowed to mature and be cut for hay, or it may be used as pasture. Oats furnish abundant pasture for sheep and hogs, which is available quite early in the season. If peas are sown with the oats, the crop should be allowed to make considerable growth before the hogs are turned in on it, as the young pea vines are easily broken off and destroyed. Sheep do less injury in this way and can be turned in on the pasture early in the season.

Mutton or pork may be very cheaply produced by allowing the peas and oats to ripen and then pasturing off the crop with sheep or hogs. This combination is particularly well liked by sheep, and as they make rapid growth and cheap gains upon it, it should be more generally used. As the crop is pastured off it costs nothing to harvest and the land is enriched, as practically all of the plant food taken from the soil is returned, together with the nitrogen taken from the air by the pea vines.

Use as a Nurse Crop and as a Cover Crop.—Oats are frequently used as a nurse crop for clover and grass, and in some sections for alfalfa. This use is only incidental, however, as the oats are sown primarily for the production of grain, while the position of this crop in the rotation immediately preceding the meadow or pasture crop makes it desirable, and in some cases necessary, to sow grass or clover seed with it. When used as a nurse crop rather less seed should be sown than when not so used, while early harvesting and the growing of early varieties are advisable. A less frequent use of oats is as a cover crop in orchards, to protect the roots of the trees by shading them in late summer and by forming a mulch and holding the snow in winter. The cover crop also serves to check the growth of the trees and to insure thorough ripening of the young wood before cold weather. Canada field peas or vetch make a valuable addition to oats when used for this purpose.

GROWING THE CROPS.

In the production of oats proper climatic and cultural conditions are of more importance than the character or even the fertility of the soil. Owing to their greater water-holding capacity loam and clay soils usually produce better crops than sandy soils. Sandy land with plenty of plant food and a moderately stiff subsoil

will grow good oats, but heavy, undrained clays are too wet and cold for the best growth of the crop. More water is required to produce a pound of dry matter in oats than in any other cereal, hence the necessity for growing this crop on land which naturally retains moisture or which is well filled with humus. On account of their liability to lodge, oats should not be grown on very rich soil or on low, undrained lands. Good drainage is essential also in the prevention of injury from plant diseases.

Fertilizers and Manures.—The quantities of the three important fertilizing elements removed by a crop of grain vary somewhat in different portions of the country, as they depend on the yield of the individual crop and the proportion of grain to straw. For this reason no general estimate of the fertilizer removed by an acre of oats can be given. According to experiments in South Dakota a 45-bushel crop of oats removed from the soil approximately 44 pounds of nitrogen, 16 pounds of phosphoric acid, and 37 pounds of potash. A 30-bushel crop of corn removed a little more phosphoric acid and potash and about one-third more nitrogen than the oats, while a 40-bushel crop of barley removed considerably more of all three of these fertilizing elements. A 15-bushel crop of wheat removed but 35 pounds of nitrogen, 9 pounds of phosphoric acid, and 15 pounds of potash. These figures show that nearly as much fertility is required to produce a good crop of oats as of any other grain, so that the common practice of using the poorest land on the farm for growing oats is not to be commended. While the oat crop is a vigorous feeder and will do better on poor soils than will most other grain crops, yet the judicious use of fertilizers or manure is usually profitable. The fertilizer problem is made difficult, however, by the fact that on rich soil oats make a rank growth, which often results in lodging and in conditions favorable to rust and other diseases.

Unless the soil is very low in fertility the direct application of barnyard manure to the crop is seldom advisable. Much more satisfactory results can usually be secured by applying the manure previous to growing some other crop in the rotation, such as corn. The oats will then get the benefit of a part of the manure and of the added humus in the soil, with less danger that a rank growth of straw will be made at the expense of grain production. On very poor soil the application of a few loads of well-rotted manure some time previous to sowing oats can be made to advantage. The manure should be applied as evenly as possible and should be well worked into the soil. Under these conditions the use of a small quantity of raw rock phosphate with the manure is usually advisable.

Experiments show that phosphorus is usually the most important addition which can be made to the soil for the production of oats, but small quantities of nitrogenous fertilizer can often be used to advantage. The oat crop makes most of its growth early in the season, when the weather is cool and before much of the nitrogen in the soil becomes available for plant food. For this reason the application of a small quantity of nitrogen in a readily available form,

as nitrate of soda, will hasten its growth and result in materially increased yields.

Liming alone is not likely to increase the yield of oats. On very sour soils or when used in connection with the plowing under of green-manure crops or stable manure, it may have a beneficial effect. Where lime was applied without manure at the Pennsylvania station it reduced the yield of oats, but where it was applied in connection with manure it increased the beneficial effect of the manure. This was in a 4-year rotation of corn, oats, wheat, and clover and timothy. The lime was applied at the rate of 2 tons to the acre previous to planting the corn crop.

While the application of lime or fertilizers to oats may not be directly profitable, the increased yields from succeeding crops may often more than make up the deficiency. This is particularly true when clover or a grass crop is to follow the oats.

Rotation.—Among the factors which determine the place of the oat crop in the rotation are the effect of the preceding crop on the growth of the oats and the effect of the oats on the following crop. Ordinarily oats are not grown after a grass or clover crop, a cultivated crop being used to subdue the sod. In sections where virgin soil is being brought under cultivation oats are usually grown on "old land," wheat and flax being the crops which are ordinarily grown on sod land if a cultivated crop such as corn or one of the sorghums is not used. When grown on sod land, especially where the sod consists wholly or in part of clover or alfalfa, oats are inclined to grow rank and lodge. Where there is less trouble from lodging, as in some of the irrigated sections of the West, oats may follow clover or alfalfa.

Oats are less influenced by the effect of the preceding crop than are most other grains, so that where wheat, barley, and oats are the main crops and rotation, if one is practiced, is arranged to suit the other grains rather than oats. Where corn or some other cultivated crop is grown, oats usually follow the cultivated crop and are followed by grass or clover, which are usually sown with the oats.

A common rotation in Iowa and Illinois, and in the surrounding States, consists of corn, oats, and grass or clover. Usually this is a 5-year rotation, two crops of corn being grown in succession, followed by oats, with grass and clover seeded with the oats; the grass is allowed to remain for two years, either as meadow or pasture, and is then plowed up for corn. The rotation is sometimes shortened to four years, either two years of corn and one each of oats and grass or one year each of corn and oats and two years of grass. The first of these two rotations is the common one where clover alone is used as the hay crop. Where winter wheat can be grown it is customary to use it as a nurse crop for grass or clover. The common rotation where both oats and winter wheat are grown is corn, oats, winter wheat, and grass or clover for one or more years. In Maine and in some of the other potato-growing sections a common rotation consists of potatoes, oats, and clover, each one year. In the spring-wheat section, if corn is grown the common rotation

is corn, wheat, oats, and grass. In some portions of the spring-wheat belt no rotation is practiced, particularly if corn and grass are not included among the staple crops. In the South oats occupy so small a portion of the cultivated area that they do not commonly figure in the rotation. A good rotation in this section which includes oats consists of corn, with cowpeas sown between the rows; oats, followed by cowpeas; and cotton. In the irrigated section oats are sometimes grown in rotation with clover or alfalfa.

Clearing the Land of Weeds.—As oats start into growth early in the season and soon make a dense shade, they are one of the best crops for clearing land of weeds. When used for this purpose, they should be sown rather more thickly than on land that is free from weeds. The crop may be cut for grain or for hay, as desired, but it should be harvested before many of the weeds that grow with it mature their seed. The land may then be pastured to keep down the later growth, or the weeds which develop after the oats are harvested may be cut with the mower or plowed under before they mature seed. If the field is plowed it should be disked or harrowed occasionally to destroy any weeds that start into growth. If fall grain is sown or if the land is used for a cultivated crop the next season, it will be practically free from annual weeds by the end of the second year.

Preparation of the Seed Bed.—Less attention is ordinarily given to the preparation of the seed bed for oats than for any other field crop. A common method in the corn belt, where the oat crop almost invariably follows corn, is to sow the seed broadcast on corn land without preparation. This method is now less used than it was a few years ago, when its prevalence was well shown by an inquiry sent out by the Iowa station in 1905. Of 452 farmers who replied to the list of questions regarding the preparation of the land for oats, more than 70 per cent neither broke nor burned the cornstalks before seeding to oats, only 13 per cent disked the ground before seeding, and a still smaller proportion harrowed before seeding. In other words, nearly three-fourths of those who replied sowed their oats broadcast on cornstalk land without preparation of any kind.

A good seed bed can hardly be prepared with fewer than two diskings, and usualy at least one harrowing is necessary. Where oats are to be sown on corn land on which the stalks are still standing it is good practice to break the stalks before disking. This can readily be done, especially on a frosty morning, by dragging a heavy pole or iron rail broadside across the field. The stalks can then be cut with a disk harrow much more readily than if left standing. Where there is much trash on the land it is sometimes advisable to rake and burn the stalks and weeds before disking. This is common practice in some sections. Ordinarily this humus-making material should not be destroyed, but should be worked into the soil. If the disks of the disk harrow are sharp they will cut the stalks into short pieces, which soon decay, and much of the trash will be covered by the disking and harrowing. Breaking the

stalks and cutting them with a stalk cutter in the fall hastens their decay.

It is always advisable to sow oats as early in the spring as the land can be worked, but proper preparation should not be sacrificed to gain a little time in getting the seed into the ground. Oats do best when sown in a rather firm seed bed, with 2 to 3 inches of loose, mellow soil on the surface. This can best be secured on corn-stalk land by breaking the stalks, double-disking either by lapping half or cross disking, and thorough harrowing with the spike-tooth harrow. Lapping half with the disk harrow leaves the surface more nearly even than when the field is cross-disked. The disks should be set to run 3 or 4 inches deep. After the seed bed is in good condition the seed should be sown and the field again harrowed.

The land is seldom plowed for oats which follow a cultivated crop. Spring plowing is not usually profitable, as there is little time to allow the subsurface to become compact, and the land is rarely in proper condition to plow before the oats should be sown. Soils which are not likely to blow or run togther can sometimes be plowed in the fall to advantage, particularly if grass seed is to be sown with the oats. A fine, smooth, mellow seed bed can thus be prepared. Fall-plowed land should be double-disked about 3 inches deep before seeding and harrowed both before and after seeding.

Preparation of the Seed.—Seed oats should be carefully screened and graded before sowing. This work is ordinarily done with the fanning mill, the light oats and some of the trash being taken out by a current of air, while the small oats and most of the weed seeds are removed by means of screens. The process should take out one-third or one-fourth of the oats, but if the seed is very light a much larger proportion should be removed by the fans. Many of the small, light oats will not germinate at all, while others produce weak plants, which materially reduce the yield. Screening also greatly reduces the proportion of weed seed, thus preventing the spread of weeds and further favoring the growth of the oat crop.

Sowing the Seed.—One of the greatest essentials in growing oats is to get the seed into the ground early. This crop grows best in cool climates and in cool weather, and is often materially injured by a few hot days when it is near maturity. Frosts or even hard freezes after the seed is sown seldom injure it, so that, as a rule, oats should be sown just as soon as the ground is in condition to work in the spring. In fact, a few farmers in the Northern States are now sowing the ordinary spring varieties of oats in the fall, just before the ground freezes. The seed usually does not germinate in the fall, but begins growth with the first warm days of spring. The advantages claimed for this practice are that the fall seeding lessens the spring rush of work and that the seed gets an earlier start than is possible with spring seeding. The dangers incident to fall seeding include germination in the fall and subsequent winterkilling, freezing after the seed germinates in the spring, and injury from alternate freezing and thawing and continued cold, wet weather. While

the practice has not yet been tested enough to justify a statement of its value, it seems to be worthy of limited trial, particularly in the drier sections, where it is most likely to prove a success. Some Ohio and Indiana farmers have grown good crops of oats from seed sown broadcast on the snow in February, depending on later freezes and thaws to cover the seed. Seeding in this way can not be generally recommended, as the chances of loss are too great.

All tests conducted by the experiment stations are favorable to early spring seeding as compared with later seeding.

The exact date of seeding naturally depends on the locality and the season.

The rate of seeding depends on the locality, the condition and fertility of the soil, the method of seeding, and the size of the seed. As with other crops, less seed is required in dry than in humid sections. Fertile soils require less seed than poor ones, as on rich land the plants grow larger and tiller more. More seed should be sown on weedy land or on land not well prepared than on clean, mellow soil. Drilling requires less seed than sowing broadcast. More bushels of large-grained than of small-grained oats should be sown on an acre. The number of grains in a measured bushel of oats ranges from 500,000 to 750,000, according to the variety. The large-grained varieties usually grow ranker and the plants occupy more space than the small-grained ones, but the difference in the size of the plants does not equalize the difference in thickness of stand caused by the greater number of plants produced by a bushel of small-grained oats.

In general, the rate of seeding in the upper Mississippi Valley ranges from 8 to 12 pecks to the acre, but in the drier sections of the West this rate is reduced by half. In the irrigated sections 6 to 8 pecks is the common rate. Where the usual rate in broadcast seeding is 12 pecks, 10 pecks will be sufficient if the seed is drilled.

Many experiments have been conducted to determine the best rate of seeding in different localities. These experiments show, in general, that tillering depends very largely on the thickness of the stand and that within certain limits the plants on thinly seeded plats will tiller sufficiently to bring the number of stalks up to that produced by thick seeding. Thus, there is often little difference in the yield of grain or straw harvested from widely differing rates of seeding. Seeding at the rate of 10 pecks is recommended when ordinary methods of preparation and seeding are followed.

Two methods of seeding oats are in common use, drilling and sowing broadcast. The greater portion of the oat crop is sown broadcast and the seed covered with the disk or smoothing harrow. The ideal method of seeding is one which distributes the seed evenly over the ground and covers it to a uniform depth of about 1 inch. Neither of these results is obtained in broadcast seeding, but both results are possible by drilling. Less seed is necessary, the depth of covering is more nearly uniform, the seed germinates more evenly, and the growth throughout the season is better when the seed is drilled.

If the seed is sown broadcast it should be covered by a shallow disking or thorough harrowing. Usually, if the field has been double-disked and harrowed and is in good condition before seeding, harrowing twice will cover the seed sufficiently. At best, however, it is impossible in broadcast seeding to cover all the seed to the same depth; some seed is left on the surface and does not germinate at all, while a small portion is covered so deep that its germination is considerably delayed.

Cultivation.—On loose soil rolling can sometimes be done to advantage after the seed is sown. The Wisconsin station found that the temperature of rolled soils was higher than that of soils not rolled. For this reason germination and early growth can sometimes be hastened by rolling. On soils which are inclined to pack and bake the roller should be used with caution, as its use is likely to increase this tendency. A light harrowing after rolling, to break the crust and hold the soil moisture is beneficial.

On land which has been plowed in the spring or which for some other reason is loose and open the use of the roller or the subsurface packer may sometimes increase the yield of oats. At the Canadian Experimental Farm at Lacombe, Alberta, on a soil of loose texture containing considerable humus, the use of the packer after seeding increased the yield in 1908 and 1909 from 69.45 bushels for the unpacked to 83.36 bushels for the packed plats. In 1908 one variety was grown, using three rates of seeding, while in 1909 two varieties, each at two rates of seeding, were grown.

Cultivation of small grain with the harrow or weeder is seldom practiced, but experiments indicate that this work can often be done to advantage, particularly in regions of light rainfall. This cultivation usually takes the form of two or three harrowings with the spike-tooth harrow or weeder. If the harrow is used, the teeth should be set rather slanting, so as not to pull out the young grain. Cultivation with the harrow is sometimes of advantage on very weedy ground, even where the rainfall is ample, as the weeds are readily killed when small. The harrow should be used, however, only on drilled fields and only after the young grain is well rooted. Harrowing at intervals of a week, beginning about three weeks after the grain is sown and continuing until it begins to make stems, is an efficient method of checking weed growth and conserving moisture for the oat crop. If grass or clover seed is sown with the grain no cultivation should be given.

Irrigation.—Oats require rather more water for their best development than wheat, though there is great difference in the varieties of both grains in this respect. It is also generally believed that oats require more water than barley, though some experiments indicate the contrary. Irrigation of oats is practiced to a considerable extent in the Rocky Mountain and North Pacific States, particularly in Montana, Idaho, and Utah. The water is ordinarily applied at two irrigations, though three or four are frequently given. When two applications are made the first is usually just before heading begins, while the second and much heavier one is

at the time when the grain begins to fill. Opinions vary greatly as to supply of water needed by this crop. It is probable that 15 to 20 inches is the most profitable quantity, though where plenty of water is available much more is ordinarily applied. The quantity of water to be applied depends upon the nature of the soil. The danger, especially where water is plentiful, is in overirrigation.

Harvesting the Crop.—Oats are usually cut with the grain binder, though in the drier sections the header is used, and occasionally the crop is harvested with the combined harvester and thrasher. When the straw is very short, owing to dry weather, or when the crop is badly lodged, cutting with the mower may be necessary. The grain may then be raked and put into cocks, which should be well built so as to shed rain. The proper time to cut oats is when they are in the hard-dough stage. If cut before this time, the grain is not well filled, shrivels in curing, and is light in weight. If allowed to become fully ripe before cutting, a considerable portion of the crop shatters out and is lost in harvesting, and the danger of damage from storms is also increased. Where a large acreage is to be harvested it is advisable to begin cutting when the grain is about to pass out of the milk stage, otherwise a considerable portion of the crop is likely to become too ripe before it can be cut.

If the grain is ripe or in the hard-dough stage when cut it may be placed at once in round shocks which should be capped to prevent damage from rain and dew. The best quality of grain can be harvested under these conditions. If the grain is green or if the bundles contain a considerable quantity of weeds, they should be allowed to cure for a few hours before shocking, and should then be placed in long shocks, which may or may not be capped. Long shocks allow the sun and air to penetrate much more readily than round ones, and are to be preferred when the grain is not well cured. Equally good protection is afforded by capping the long shocks. Grain which is wet from dew or rain should be allowed to dry before it is placed in shocks. In sections where strong winds prevail during the harvest season capping is not advisable, as the caps blow off and the grain in the cap sheaves is injured by contact with the ground.

Stacking.—Where grain is stacked it is important that the stacks be well built. If the stacks are so carelessly put up that they will not shed water the grain might much better be allowed to stand in the shock. The bottom of the stack should be set up from the ground slightly by laying down old rails or other material to keep the grain from coming in contact with the earth. This will prevent the absorption of moisture from below. The shape of the stack is less important than the manner in which the bundles are laid. They should be so placed that only the butts are exposed, and so that water will readily run off the sides of the stack and not penetrate enough to wet the grain. The round form of stack probably sheds water better than the long ricks sometimes constructed. If the rick is built the top should be covered with straw or wild hay to keep out water.

Shock Versus Stack Thrashing.—Whether oats are to be stacked or allowed to remain in the shock until they are thrashed depends very largely on local conditions. If there is a reasonable certainty that a thrashing outfit will be available after the grain has had time to cure in the shock but before it is exposed unnecessarily to weathering, the relative cost of shock and stack thrashing is the point on which the decision must be made. According to investigations conducted by the Minnesota station in co-operation with the Bureau of Statistics of the Department of Agriculture, the labor cost of thrashing from the shock in southern Minnesota was 4.3 cents to the bushel, while that of stack thrashing was 5.2 cents. In northwestern Minnesota the relative labor cost of the two operations was 3.6 cents and 4.9 cents. It is probably safe to assume that stacking adds about 1 cent a bushel to the cost of producing oats.

In the report of the investigations just mentioned the relative merits of shock and stack thrashing are thus compared:

The possibility of improving the grade of grain enough to pay the additional cost of stacking and stack thrashing depends in any locality upon the availability of machines, the availability of labor, and the climatic conditions prevailing at harvest. The intelligent stacking of grain during a majority of Minnesota harvests is cheap insurance against bleached, sprouted, and bin-burnt grain. If the weather is favorable and a machine can be put in the field as soon as the grain is fit to thrash, a slight saving will be made as compared with stacking and stack thrashing. On the other hand, if the shocks must weather for several days or, in some cases, for several weeks before a machine can be obtained, the loss in grade is considerable and stacking the grain would have been profitable.

In general, conditions during harvest in the greater portion of the oat-growing sections are similar to those in Minnesota, and on small farms stacking oats is generally to be recommended. On the larger farms of the West where there is less danger from rains and where a thrashing machine is available at the time the grain is ready to thrash, shock thrashing will no doubt continue to be the general practice.

Thrashing.—The grain should be thoroughly dry when it is thrashed, as it not only thrashes better but there is danger that both the grain and the straw will heat and mold if thrashed when damp. It is important to see that the thrashing machine is thoroughly cleaned before thrashing is begun. This will not only prevent mixing the grain with that from a neighboring farm, but will also check the spread of weeds which may be carried from place to place in the separator. The operation of the machine should be carefully watched to see that all the grain is removed from the straw and that the separation of the grain from the chaff and dirt is as complete as possible. The concaves should be so set that they will remove all the grain, but not so close that they will hull it. The straw should be carefully stacked, so that it will be injured as little as possible by rains. If there is available room, running the straw into the barn is both economical and convenient.

Storing the Grain.—Oats, like other grains, should be stored in bins that are protected from the weather and well set up from the ground, so that the grain will not absorb moisture. The grain should be dry when it is put in the bin and should be kept dry, as otherwise there is considerable danger that it will become musty and discolored. Mustiness not only lowers the feeding value of oats, but may make them dangerous to the health of the animals. It is important that the bins be so constructed that they may be kept free from vermin and so that the grain can be easily handled. Placing the bin as near as possible to where the oats are to be used is desirable. In sections where grain weevils and other insects seriously affect stored grain, the building of tight bins which can be fumigated is sometimes necessary.

Yields.—In the United States the highest yields of oats are harvested in the North Pacific and Rocky Mountain regions where the crop is irrigated or the rainfall is heavy. Under irrigation the production of 100 to 125 bushels to the acre is not uncommon, while yields of 150 to 175 bushels are sometimes reported.

In several of the states where irrigation is practiced the average yield is more than 40 bushels to the acre. In comparison with the average yield of the United States of about 30 bushels to the acre, the average yield of oats in Germany is about 50 bushels, in the United Kingdom 45 bushels, in France 28 bushels, and in Russia 20 bushels. The cool, moist climate of Germany and of the United Kingdom is particularly well adapted to the production of high yields of oats, which are further increased by the good methods of cultivation practiced.

VARIETIES FOR DIFFERENT SECTIONS OF THE UNITED STATES.

Varieties of oats may differ in the size, shape, or color of the grain, in the length of time they require from seeding to maturity, in the shape and size of the panicle, in the yield of grain or of straw, and in the time when they may be sown. The grain may be large, medium, or small; it may be long and slender or short and plump; the color may be white, yellow, black, gray, or brownish-red. The difference in the time necessary to reach maturity for different varieties at any given place is from fifteen to twenty-five days; all varieties mature more quickly in the central portion of the United States than in the northern part. In the southern and central portions of the country the earliest varieties may mature in eighty-five to ninety days; in the cooler climate of the north the later varieties may require one hundred and twenty-five to one hundred and forty days. Most of the varieties grown in the United States are adapted to spring seeding, but a few, like Winter Turf, are sown in the fall in the Southern States, while others, like Red Rustproof, may be sown either in the fall or the spring.

The number of varieties of oats grown in the United States is very large, though a number well adapted to the conditions in any particular section is comparatively small. Several hundred varietal names are to be found in the catalogues of American seedsmen, but in many instances different names are applied to the same

variety by different seedsmen or in different sections of the country. A good example of this is to be found in the Winter Turf oat, which is variously known as Gray Winter, Virginia Gray, Turf, Grazing, Virginia Winter, and Winter Turf, while several similar names are less commonly applied to it. Every year new varieties of oats are offered by seedsmen, while other names are omitted from their lists, and varieties which may have been common in some sections ten or fifteen years ago have now almost entirely disappeared from cultivation.

In the northern portion the later, white varieties adapted to the northern belt succeed in favorable seasons. In the entire southern portion of the country, which is heavily shaded on the map, the varieties which do best when sown in the spring are the Burt and the Red Rustproof. For fall seeding the Winter Turf, a hardy, medium-sized, gray oat, and in the warmer portions of the area the Red Rustproof are the varieties which are usually used.

Cost of Production.—Estimates of the cost of producing an acre or a bushel of oats vary greatly. Much depends on the labor used in preparing the land for seeding, the yield produced, the cost of thrashing, and the rent or interest charges on the land. Professor Hume, of the Illinois College of Agriculture, estimated the cost of producing 33 bushels of oats to the acre in central Illinois, in the cheapest possible manner, at $5.45, or 16 cents a bushel, land rental not included. The cost of producing oats in three different sections of Minnesota was reported by the Minnesota station as $9.84, $8.83, and $6.31 to the acre, respectively, with land rental included. Owing to the difference in yield the cost of producing a bushel of oats in these three sections was practically the same, 21 cents. The cost of producing a bushel of oats at Ottawa, Canada, was estimated in 1903 at 21.7 cents. The acre cost of production under irrigation is much greater than where there is no irrigation, but the cost per bushel is not materially increased, owing to the greater yields. Farm estimates of the cost of production are usually lower than the figures just given, as farmers often fail to take into account the depreciation in value of the farm machinery and other items which are properly chargeable to the crop.

The ordinary cost of producing 33 bushels of oats to the acre in Illinois, with the land rental included, according to Professor Hume, is $11.84. At 26 cents, the prevailing price per bushel in Illinois at the time this estimate was made, this crop would sell for $8.52 an acre, or at a loss to the farmer of $3.32, while a crop of 100 bushels, which cost $20.21 to produce, would sell for $26, or a profit of $5.79. At 38 cents, the average price in Illinois in December, 1909, the 33-bushel crop would return a small profit, while the 100-bushel crop would return a liberal one, at least $15 to the acre, allowing for a slight increase in the cost of production. At 26 cents, the average farm price in Minnesota for 1904, 1905, and 1906, when the estimates of cost of production in that State were made, the net profit in the three sections was $2.38, $2.35, and $1.36 per acre, respectively. The narrow margin of profit shown

in all these figures indicates the necessity for increasing the acre yield of oats if the crop is to be grown at a profit.

WINTER OATS FOR THE SOUTH.

Some of the problems in the production of winter oats in the Southern States are quite different from those which must be solved by the grower of spring oats in the northern and central portions of the United States. Not only are the varieties different, but the proper selection of soils and fertilizers and the time and manner of seeding to secure the best results in the production of the crop are quite at variance with the best practices in the sections where spring oats are extensively produced.

The production of winter oats is more or less practicable throughout the sections usually known as the South Atlantic and South Central States, which, for convenience, will be referred to as the Southern States, although they include some to which that term is not usually applied.

Value of a Winter Grain Crop in the South.—Farm conditions in the South can be improved by the use of a greater variety of crops and of definite systems of crop rotation and by the keeping of a greater number of live stock. A rational crop rotation in the South is one which occupies the land practically the entire year, protecting the soil from washing during the winter by the use of a growing crop, such as crimson clover, vetch, or winter grain. Increasing the number of live stock requires the production of more grain for feeding. Winter grains combine the two essential features, grain production and soil cover, in one crop. Within reasonable limits they supply a third desirable feature, winter pasture. On the other hand, spring-grain production in the greater portion of the Southern States is far from certain. Winter varieties of wheat and barley have almost entirely replaced the spring types of these grains, so that the only spring-grain crop now generally sown in the South is oats.

Fall-Sown Compared with Spring-Sown Oats.—The advantages of fall seeding of oats over spring seeding wherever the winter varieties can be grown are numerous. The yields are usually better, the fall-sown oats mature earlier, the land can usually be prepared in better shape in the fall than in the spring, fall seeding interferes less with other work than does spring seeding, poorer land and less fertilizer can be used for the fall-sown crop, and the fall-sown crop furnishes a cover for the soil during the winter and prevents washing.

Winter oats almost invariably yield more than spring oats, owing to their earlier maturity, stronger growth, and greater freedom from disease. If a part of the stand is lost from winterkilling, the plants which are left stool vigorously, so that the stand at harvest is much better than was apparent in early spring. Fall-sown oats usually grow more vigorously and mature from ten days to two weeks earlier than those sown in the spring. This earlier maturity often marks the difference between success and failure, as the later maturing grain is more likely to be injured by storms

or drought and by rust and other plant diseases. Oats require comparatively cool weather for their best growth, so that those which mature earliest usually yield best, as the conditions are better suited to their development. The early maturity incident to fall seeding also allows the crop to be removed from the land earlier than spring seeding, giving more time for the preparation of the soil, seeding, and the growing of the following crop.

In order to obtain a satisfactory crop of spring oats it is necessary in the extreme South to sow the grain in January or early in February, and in February or early March farther north. At this time the ground is usually wet and cold and is not in condition to make a good seed bed. Clay soils may be materially injured by working them when wet, and only very sandy ones can be handled satisfactorily in this condition. On the other hand, at the time when the grain should be sown in the fall the ground is ordinarily in good condition to work, and a good, mellow seed bed can be prepared. This better preparation starts the young plants into vigorous growth and they go into winter in good shape. Seed sown in the winter or early spring on poorly prepared land is handicapped by this poor preparation, grows slowly, and is never as vigorous as that sown in a good seed bed.

Varieties of Winter Oats.—The varieties of winter oats commonly grown in the South are of one or the other of two types, the Red Rustproof and the Winter Turf. The Red Rustproof type includes the common Red Rustproof under several similar names and several selections and strains of that variety under entirely different names. Only one variety of the Winter Turf type is commonly grown, though many names are applied to it.

Sections Where Winter Oats Can Be Grown.—No definite limits can be drawn marking the sections where winter oats can or can not be grown. The variety, the method of preparation, the time and manner of seeding, the kind of land on which the crop is grown, and the climatic conditions of the particular section must all be taken into account. Varieties of the Winter Turf type can be grown in colder sections than those of the Red Rustproof type. Oats sown early in drills or furrows on well-prepared land often survive the winter in the same locality where those sown under less favorable conditions winterkill. Winter oats may be successfully grown in a particular section for several years; a season may then come when the crop will be entirely destroyed by cold or other unfavorable conditions.

SOILS AND FERTILIZERS FOR OATS.

As quick growth and early maturity are essential to the success of the oat crop in the South, the soils and fertilizers which will produce these results should be selected.

The soil for oats should be reasonably fertile and should hold moisture well, as this crop requires a large amount of water and may be severely injured by drought. Any soil which will grow a good crop of cotton or corn will produce oats, though the best results will be secured on the heavier loams. A well-fertilized sandy

or sandy-loam soil will generally prove more satisfactory, particularly if it is well filled with humus, so that its moisture-holding capacity is high. Good drainage is essential, however, as winter-killing is most likely to occur on poorly drained land. Rust and other diseases are also most severe on low, poorly drained areas.

Barnyard manure is not usually available in sufficient quantity to be much of a factor in keeping up the fertility of the soil.

The best and cheapest method of adding nitrogen is by growing a green-manure crop, which gathers nitrogen from the air and stores it in the soil. Green manures also supply humus or vegetable matter, which is usually lacking in southern soils.

Barnyard manure is an excellent fertilizer for almost all crops, as it contains all the elements of plant food and a considerable quantity of humus as well. One of the best methods of using barnyard manure on oats in the South, where it is seldom available in large quantities, is as a top-dressing applied in the late fall or early winter. When so applied it serves as a protection to the crop during the winter and at the same time adds fertility to the soil. It is probable that the largest increase to the ton of manure will result from the application of about 5 tons to the acre.

If nitrogen has been supplied in liberal quantities through the growth of legumes as green manures, it need not be added in commercial fertilizers. If, however, a green-manure crop does not immediately precede the oats, or if the preceding crop was light, some readily available fertilizer carrying nitrogen (ammonia) should be used. The best results on most classes of soil are to be obtained by adding this nitrogen as a top-dressing in the spring, about two months before harvest. The nitrate should be sown broadcast and worked into the soil with a harrow. Cottonseed meal or dried blood may be used to supplement the nitrate of soda. On sandy soils the application of about 25 pounds of nitrogen (50 pounds of nitrate of soda and 200 pounds of cottonseed meal or 100 pounds of dried blood) to the acre is recommended.

On clay soils this may be reduced to 18 or 20 pounds of nitrogen (30 pounds of nitrate of soda and about 150 pounds of cottonseed meal). If the oats are grown for hay, more nitrogen should be used than when they are grown for grain.

Rotation.—The most common cultivated crops in the South are cotton and corn, and as corn is removed from the land earlier than cotton, oats usually follow the former. One of the best rotations which can be devised for the cotton-growing section is as follows: First year, cotton; second year, corn, with cowpeas planted at the last cultivation; third year, winter oats, followed by cowpeas.

Outside the cotton-growing section a good rotation, including oats, is as follows: First year, corn, with cowpeas in the corn; second year, oats, with clover or grass seeded in the oats; third year, meadow or pasture.

If it is desired to grow wheat, oats may be sown after the corn and cowpeas planted after the oats are harvested. Wheat may then be planted after the cowpeas and grass seeded with it. Potatoes

or other cultivated crops may be substituted for corn if desired. Where clover does not succeed, or where a permanent meadow is not wanted, the following rotation is a good one: First year, corn, with cowpeas in the corn; second year, wheat, followed by cowpeas, which are cut for hay; third year oats, followed by cowpeas, sorghum, or some other forage crop.

If desired, rye may be sown after the forage crop is harvested, or the forage crop may be omitted and crimson clover sown early in the fall. The rye or crimson clover is then plowed under the following spring for corn. Other rotations along similar lines can be arranged, according to the crops it is desired to grow.

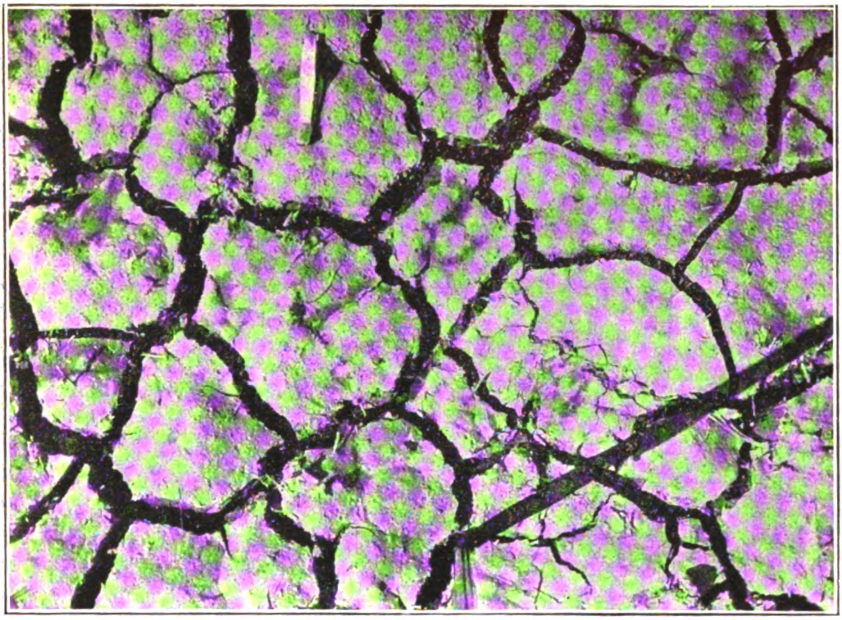
Preparation of the Land.—The method of preparation of the land depends to some extent on the previous treatment it has received and on the character of the soil. In any case a loose, mellow seed bed should be prepared, as the success of the crop depends in a large measure on the condition of the seed bed and on the fall growth.

In general, the land should be plowed 5 or 6 inches deep at least a month before the oats are to be sown, and the plow followed immediately by the spike-tooth or other smoothing harrow. Double disking and another harrowing should then put it in shape for drilling. Additional disking and harrowing may be necessary, if the ground is hard and rough. If it is loose from recent plowing, the roller or plank drag may be used to make a more compact seed bed. Rolling may often be done to advantage on loose, sandy land, but on the heavier loam and clay soils the roller should always be followed with the harrow to break the crust and check evaporation. If the land has been thoroughly plowed the preceding spring for some other crop and has been thoroughly cultivated throughout the season, disking and harrowing may take the place of plowing, especially on sandy land. The fertilizer may be distributed when the seed is sown if the oats are to be drilled; otherwise, it should be applied before the last harrowing.

Sowing the Seed.—The success of the winter-oat crop depends in a large measure on the time, the rate, and the manner of seeding. Early seeding with the grain drill or in open furrows, using 2 bushels of seed to the acre, is recommended.

Winter oats are less hardy than winter wheat or barley and for that reason should be sown earlier, so that the plants may become well rooted and make considerable top growth before cold weather. Oats are seldom attacked by insects in the fall, so that there is no necessity for delay in seeding, as with wheat where the Hessian fly is common. In the extreme South, seeding need not be done until November, but farther north September and October are the best months.

Winter oats are sometimes sown broadcast, but this method is not to be recommended. When sown broadcast and harrowed in, much of the seed is left near the surface, even in well-prepared ground, so that many of the plants are shallow rooted and are killed by heaving or cold. A better method, where broadcast seeding is



Surface of the Bad Land: Crust Formed After Irrigation: Truckee-Carson Experiment Station, 1908. Dept. of Agr.

Twining and Slicing Harrow Followed by Corrugated Roller: Preparing Seed Bed: Truckee-Carson Experiment Station, 1908. Dept. of Agr.

necessary, is to sow the seed on clean ground which has been disked, covering it about 3 inches deep with the turning plow. The ground should then be left rather rough, as the uneven surface furnishes some protection for the plants. More seed should be used in broadcast seeding than in drilling.

The use of the grain drill in sowing winter oats is strongly recommended. Drilling produces a more uniform stand and more even germination and growth than broadcast seeding. Drilling also requires less seed and the plants are less likely to winterkill. Drilling at least 3 inches deep on well-prepared land, leaving the drill furrows as open as possible, is advised. Drag chains should not be used on the drill, nor should the land be harrowed after drilling. This leaves the seed in the bottom of shallow furrows, which in a measure protect the young plants from winterkilling.

As the grains of varieties of the Red Rustproof type are likely to stick together, the drill should be watched closely to see that the seed is being evenly distributed. A drill with a good force feed will sow this variety quite satisfactorily.

The Georgia Experiment Station a number of years ago devised what is known as the open-furrow method of seeding oats. By this method the seed is sown in drills from 16 to 24 inches apart, the ordinary single-row planter or a specially devised drill being used for the purpose. If desired, a drill with a fertilizer attachment may be used and the fertilizer distributed in the furrows with the seed.

The seed is sown in drills or furrows several inches deep, so that the roots and crowns of the plants are 2 or 3 inches below the surface. The rains and alternate freezing and thawing partially fill these furrows, but the plants are still left well below the surface. Running the drills across the usual direction of the winter winds is recommended by the Georgia station as an additional protection, as the slight wall of earth prevents the full force of the wind from striking the plants. Thus, if the coldest winter winds are ordinarily from the northwest, the drills should run northeast and southwest.

The rate of seeding usually recommended for Red Rustproof and similar varieties of oats when sown with the open-furrow drill is 2 bushels to the acre. When sown with the ordinary drill 2½ bushels is about the proper rate. Broadcast seeding requires still more seed, from 3 to 4 bushels being necessary. As the Winter Turf oats is somewhat hardier and stools more than the Red Rustproof, it may be seeded at a lower rate, from 1½ to 2 bushels when drilled or 2½ bushels when sown broadcast. In the northern portion of the winter-oat area, where the danger from winterkilling is great, and farther south when late seeding is necessary, the rate of seeding should be somewhat increased.

From 2½ to 3 bushels of the Red Rustproof or Culberson and 2 to 2½ bushels of the Winter Turf are about the proper rates of seeding for the colder portions of the winter-oat belt. When the crop is to be used for pasture or hay somewhat heavier seeding is advisable than where it is grown for grain. When used as a nurse

crop for grasses or clover, or when grown with crimson clover or vetch, less seed should be used than when oats are grown alone.

Treatment of the Land After Seeding.—Harrowing in the early spring will help to keep weeds in check and will also loosen the hard surface soil and prevent loss of moisture. When the open-furrow method of seeding is used the ridges between the rows should be leveled down in the spring with the harrow. Winter oats, like other winter grains, are sometimes used as pasture for stock. Early seeding is particularly essential when the crop is to be pastured in the fall. Pasturing at this time always increases the danger from winterkilling, as it lessens the protection afforded by the leaves. Winter oats should not be pastured as closely as winter wheat or rye, as the oats are less hardy than the other grains. Pasturing in the spring delays maturity. As earliness is essential to the production of a good crop of oats the value of the pasture does not usually make up for the loss in yield of grain. Winter-grain fields should never be pastured when the ground is wet, as the trampling injures the physical condition of the soil. Harrowing in the spring to loosen soil which has been packed by pasturing is beneficial to the crop.

IMPROVEMENT OF THE OAT CROP.

Nearly 32,000,000 acres were devoted to the production of oats in the United States in 1907. This was the largest acreage reported up to that time, but the acre yield was the lowest since 1893 and among the lowest recorded by the Bureau of Statistics of the United States.

Mechanical Selection.—Much has been said and written about the use of the fanning mill and other means of seed separation by gravity or wind power for the improvement of seed oats. Actual field tests carefully conducted by several experiment stations indicate that little permanent improvement of the variety results from these methods of selection. If the seed is carefully cleaned each year, however, the work will be fully justified by the removal of weed seed and the small shriveled grain, which, if it grew at all, would probably produce weak and unproductive plants. The ordinary field crop of oats is a mixture of several varieties, some of which are necessarily inferior. Mechanical selection can not, of course, purify the strain by the removal of these mixtures, which are often the cause of unsatisfactory returns. This can be accomplished only by hand selection.

Introduction of New Seed.—The introduction of new seed includes importations from foreign countries and transfer from one locality to another within the United States. Many of our best varieties have been introduced from foreign countries; indeed, it is probably true that more good varieties of oats have been introduced from abroad, especially from Europe, than of any other cereal. This is largely due, however, to the fact that little attention has been given to the production of new varieties of oats in the United States. Notable among the introductions of recent years have been Swedish Select and Sixty-Day, introduced by the United States De-

partment of Agriculture, and Kherson, introduced by the Nebraska Agricultural Experiment Station. While much has been done in this line in the past, we can not depend entirely on this source for the future, as we have practically exhausted the list of existing varieties in Europe, and highly specialized varieties bred there are unlikely to succeed over any large area of the United States. The selection and improvement of those varieties already introduced which have proved of value can best be carried on in our own country in the sections to which they are adapted.

Little permanent improvement can be secured by the exchange of seed from one locality to another. A variety which does well in one State or section will not necessarily succeed in another, even though conditions are apparently similar, whereas the general tendency is to make these transfers between localities with greatly varying conditions of soil and climate. The transfer of plump, heavy grain grown under irrigation in Montana can hardly be attended with success when the succeeding crop is grown under the very different conditions of Iowa or Illinois. Where improved high-yielding varieties can be secured from near-by growers, their purchase to replace common or inferior stock is to be recommended, but it is not advisable to secure seed oats from a section in which the conditions are widely different from those under which the crop is to be grown.

Use of the Seed Plat.—A practical method of improving the oat crop, though one which involves some time and expense, is the use of the small seed plat. This requires the selection of a considerable quantity of good heads from the field after the grain matures, and just before it is harvested. Care should be exercised in selecting the heads, so as to get them as nearly as possible of one type. Only plants which show superior qualities under ordinary conditions should be selected. Those which stand alone, near the edge of the field, or which are otherwise especially favored, should be rejected. The heads selected should be thrashed by hand and the grain secured should be sown on a plat of well-prepared land the following spring. The crop should be harvested and thrashed separately from the main crop. At thrashing, the first portion to go through the machine should be rejected, as it is likely to contain a mixture of other grain. The grain from the seed plat should be used the succeeding year for sowing the general crop, or such portion of it as the quantity of seed secured makes possible.

To effect permanent improvement, the best heads should be selected from the seed plat at each harvest to plant the seed plat of the next year. The quantity selected will, of course, vary with the size of the seed plat desired. If possible this should be large enough to furnish seed for the general crop of the following year. Where the acreage is considerable, another year is required for the transfer from the seed plat to the general crop. For instance, enough heads are selected the first season to make one bushel of seed. This is sown on a half acre and produces 25 bushels. The 25 bushels will sow 10 to 12 acres the following year, which should produce enough

to sow several hundred acres the succeeding year. The length of time from seed plat to general crop will, of course, depend on the ratio of size of the small plat to the acreage of the general crop.

Individual Plant Selection.—The most reliable and, at the same time, the slowest means of improvement is by the selection of individual plants and the establishment of pedigreed strains. Individual heads should be selected from the field crop as for the seed plat, but, instead of bulking the seed when thrashed, the seed from the several heads should be planted in separate rows.

The seed from the individual heads is planted the first year in

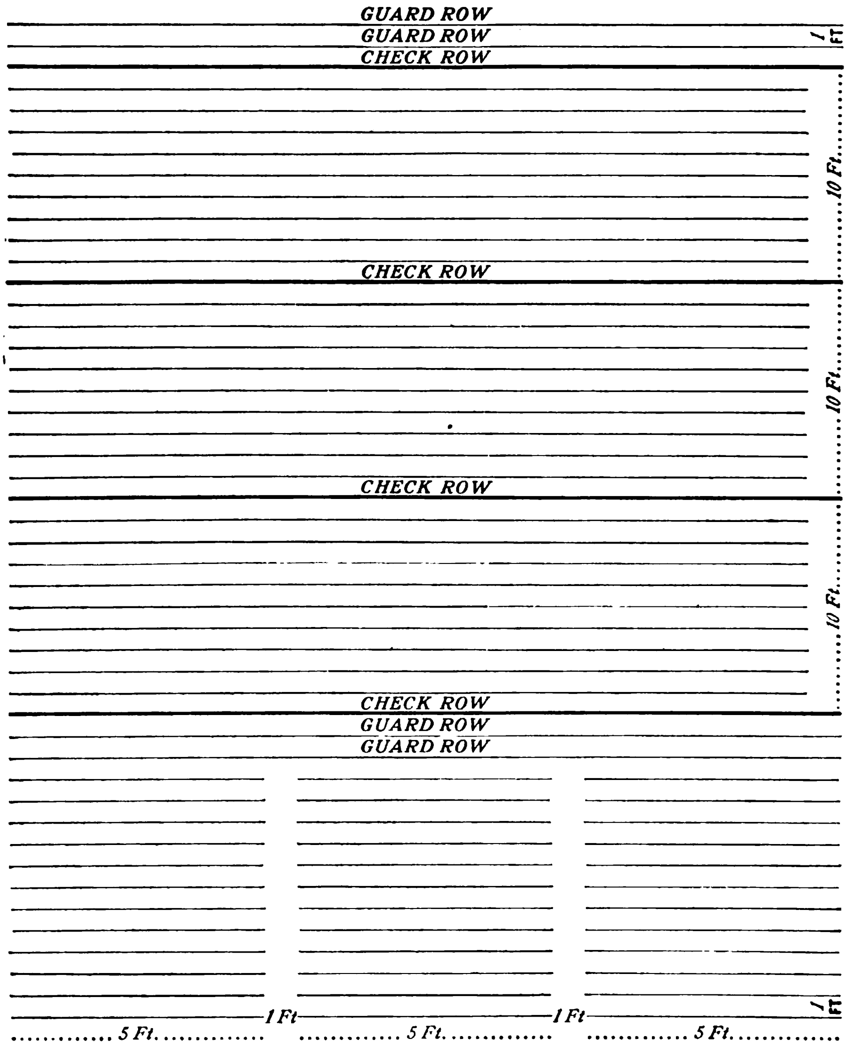


Diagram showing the planting plan of seed plat for the improvement of oats by individual plant selection.

rows 5 feet long and 1 foot apart. If a considerable number of rows are planted, it will be found convenient to run them in three series, with a narrow space between the series, as shown in the diagram. If weeds are numerous, one or two hoeings may be necessary. At harvest time the plat should be gone over carefully, and those rows which appear to be low in yield, or are particularly subject to lodging, disease, or undesirable qualities of any kind, should be discarded. Those of outstanding value should be harvested and thrashed separately, and retained for further testing.

The next year the seed from these rows should be planted in rows 17 feet long and 1 foot apart, planting every tenth row of a standard variety or of the bulk seed from which the original selections were made, for comparison and for the detection of soil variations. Each of the short rows of the preceding year should have produced enough seed for two or more of these 17-foot rows. The several rows of any particular strain should be planted in different parts of the plat so as to equalize any variation in the soil. Their location should be carefully noted, so that they may be compared with each other and the seed combined after harvesting and weighing. These 17-foot rows contain approximately one-sixteenth of a square rod, or 1-2560 of an acre. At a common rate of seeding in sections where oats are an important crop, 2½ bushels to the acre, one-half ounce is sufficient for one of these 17-foot rows. At harvest time the plat should again be carefully studied and only the most promising strains retained. Each row should then be harvested, thrashed, and weighed, and the weight recorded.

The test the third year is along similar lines. Two or more 17-foot rows should be planted of each of the strains which yet remain, and the check rows should be used as before. In addition, however, plats should be planted of several of the most promising strains, so that they may be increased as rapidly as possible.

The fourth year the few remaining strains are again tested as before, and plats of considerable size should be planted of those with the best records. After the harvest of this year, all should be discarded except those of outstanding excellence. These best strains should now be in sufficient quantity for field tests, and if of real value should be distributed to neighbors and tested under varying conditions to demonstrate their general adaptability. If the strain proves its excellence over a considerable area, a name should be given it, to prevent confusion with other varieties.

New strains selected either from the general crop or from the row tests may of course be introduced at any time by starting them in the 5-foot rows and adding them to the general series of 17-foot rows the following year.

A permanent record should be kept of the different strains. This record should show the essential facts regarding the performance of a given strain from the time the original selection is made. For convenience, each selection should be given a number, and the number should be retained until the strain is discarded or given a permanent name as a variety worthy of distribution. If selections are

made from any of the strains they should retain the original number and be given a second selection number as well. Thus, if selections are made from strain 25 they should be designated as 25-1, 25-2, 25-3, etc. If several varieties are used, either the name of the variety should be used with the selection, or the variety should be designated by a number which precedes the selection number. Thus, we may have Silvermine 1, Silvermine 2, etc., or 1-1, 1-2, etc. In this latter case the first figure of each couple designates the number of the variety, and the second figure the selections of that variety. Selections of variety No. 2 would be numbered 2-1, 2-2, etc. The sample page from a notebook shown below, which can be made by ruling vertical columns on ruled paper, illustrates the system of numbering and the essential notes which should be taken each season on all the selections. These notes should be kept in a permanent cover, such as the loose-leaf binders which are usually obtainable at stationary stores.

Record of Oat Selections for 1908.

Selection number	Row No.	Date				Resistance to—			Yield of grain	Quality
		Planted	Came up	Headed	Ripened	Rust	Lodging	Shattering		
						P. ct.	*P. ct.*	*P. ct.*	*Oz.*	
114	519	4-3	4-14	6 12	7 10	80	90	100	14.5	No. 2
114 1	520	4-3	4-14	6 12	7-10	85	98	100	15	No. 2
Check	521	4-3	4-14	6-14	7-11	80	95	100	13	No. 2
114-3	522	4-3	4-14	6-12	7-10	85	80	100	12	No. 2
414-5	523	4-3	4-14	6-13	7-10	75	75	100	14	No. 2
115	524	4-3	4-15	6-15	7-14	75	80	95	15	No. 3
115-1	525	4-3	4-15	6-15	7-14	75	80	95	12	No. 3
115-4	526	4-3	4-14	6-15	7-14	75	70	98	15	No. 3
115-4 1	527	4-3	4-14	6-15	7-14	85	90	100	16.5	No. 2
118	528	4-3	4-14	6-12	7-10	95	99	95	14	No. 2
119	529	4-3	4-14	6-12	7-10	90	80	95	11	No. 3
120	530	4-3	4-14	6-15	7-12	80	60	100	10	No. 3
Check	531	4-3	4-14	6-14	7-11	80	95	100	14	No. 2
120 1	532	4-3	4-14	6 15	7-12	80	75	100	10.5	No. 3

As shown in the above table the rows of the plat are numbered consecutively, with every tenth row as a check. Selection 114 and three selections from it were planted, 1, 3, and 5. This indicates that selections 2 and 4, and selections of this strain bearing higher numbers than 5, have been discarded in previous years. Of strain 115 we have two selections, 1 and 4, and a reselection of 4, recorded as 115-4-1. No further selections have been made of strains 118 and 119. The selections which have the numbers 116 and 117 have been discarded.

All dates are recorded by figures representing the month and day of the month. Thus, the date of planting was 4-3, or April (the fourth month) 3. Resistance to rust is recorded as the percentage of freedom from this disease. Resistance to lodging and shattering are entered in like manner. Selection No. 114-1, which lodge very little, is marked 98 per cent resistant, while 114-3, in which there is considerable lodging, is given only 80 per cent. The yield is recorded as ounces of thrashed grain to the row. Quality

may be indicated by the market grades No. 2, No. 3, etc., or by percentages.

Hybridization.—Few hybrid varieties of oats have yet been produced, practically all of the work of improvement having been accomplished by selection. Hybridization of the small grains is comparatively difficult, and the problem of selection so complicated that the farmer is hardly justified in attempting to hybridize. For the present at least, while there is so much to be accomplished by selection, his efforts can well be confined to that field, leaving the hybrid problem to the professional breeder.

SWEDISH SELECT OAT.

In the region between the Great Lakes and the Rocky Mountains one of the best-known varieties of oat at present is the Swedish Select. The annual production of this variety in the area mentioned is already at least 50,000,000 bushels, and in certain localities it has for some time entirely replaced all other kinds. It is the most popular oat in Wisconsin and adjacent districts, and the acreage sown each year has increased rapidly. Yet up to 1899 this oat was quite unknown in North America.

The Swedish Select oat was introduced into the United States in the spring of 1899 in time for planting that season. It was obtained, along with other cereals, while making an exploration of the cold and semiarid regions of Russia and western Siberia in 1898-99 in search of cereals adapted to corresponding conditions in this country. At the same time two other oat varieties were obtained, one of which, the Tobolsk, is of much value, but the Swedish Select is proving to be by far the best of the three in nearly every respect. It originated in Sweden as a pedigree variety developed by selection many years ago and was afterwards grown in Finland and in St. Petersburg Province, Russia. Under the severe weather conditions of these localities it became well acclimated for a cold and dry climate.

The Swedish Select variety is a large-grained white oat, with a spreading top or panicle. The distinguishing marks are a blunt, plump kernel, with, usually, dark, slightly twisted awns and a heavy weight per bushel. It is a very prolific variety, which quality, together with the size and weight of the kernel, is no doubt the result of previous selection. The usual weight per bushel is 34 to 36 pounds, while in Montana a weight of 44 to 46 pounds is not rare. In order, therefore, to appreciate its real superiority over other varieties in yield per acre, comparison must be made on the basis of bushels by weight instead of measured bushels. It also grows to a considerable height and produces much straw, its chief fault being a tendency toward overproduction of straw when grown on rich or low land. The roots are large and vigorous, giving the plants hardiness in cold or dry seasons. This quality was probably developed during the period of acclimation in northern Russia.

Results of Trials in This Country.—Only 20 bushels of seed of the Swedish Select oat were obtained in the original introduction. One other importation of 160 bushels was made in 1901. However,

a large percentage of the present production has descended from the 20 bushels received in 1899.

Trials by Experiment Stations.—A large part of the seed of the first introduction was placed immediately with the agricultural experiment stations in the Northern States and planted in the spring of 1899. From this time forward the most extensive trials have been made at the experiment stations in Wisconsin, North Dakota, and Montana.

WISCONSIN.

The results obtained by the Wisconsin Agricultural Experiment Station have been exceedingly interesting. Only 6 pounds of seed were sent to the station, and this quantity was sown on a tenth-acre plat.

The results were so favorable that an effort was put forth to improve them by selection and careful grading of the seed for each season's crop. In all comparisons with selected varieties of oats the Swedish were equal to the best in point of yield and had several desirable characteristics superior to other varieties.

Concerning the good qualities of this variety it was said that the Swedish Select oats (Wisconsin No. 4) seem especially adapted for high, well-drained land, and the best-known returns from clay-loam soils. The great root development is one of the characteristics of the Swedish oats, which enables the plant to resist drought better than any other variety tested. The straw is coarse and is noted for its stiffness and power to withstand lodging. The Swedish oats lodged for the first time during the four years' test on the experimental farm the past season, this being due to the severe storm of July.

On the experiment station farm such good results were obtained in 1899 and 1900 that 7½ acres were sown in 1901, with the view of increasing the quantity of seed for distribution throughout the State. This crop made 306 bushels, a yield of 40.8 bushels per acre, in spite of the serious drought of that season. This drought, though it appears to have been particularly severe at Madison, where this good crop of Swedish Select oats was grown, was general throughout the State, and, in fact, throughout the Northwest. The average yield of oats for the State was thereby reduced to less than 30 bushels per acre. There is shown, therefore, in this comparison a striking exhibition of the drought-resisting quality of the Swedish Select.

The yield per acre of the Swedish Select oat as an average for 10 years is 50.8 bushels and is 8.5 bushels greater than the average yield of all other varieties tested during this time. An average of the highest yield reached by any other variety during the period is 63.1 bushels. This statement must not be misunderstood. The highest yield was not made by the same variety each year. The Swedish Select made the greatest average yield for the 10-year period.

The results of a 10-year yield test of the Swedish Select oat in comparison with that of a number of other good varieties at the Wisconsin Agricultural Experiment Station are summarized below in

bushels per acre, the average yield for the State being given also for further comparison:

Yield to the acre of the Swedish Select oat compared with that of other varieties grown at the Wisconsin Agricultural Experiment Station and throughout the State from 1899 to 1908, inclusive.

Year.	Swedish Select.	Highest yield of any other variety.	Average of all other varieties.	Average yield of oats in Wisconsin.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*
1899	50.6	65.0	49.4	36.0
1900	64.5	79.2	49.4	32.0
1901	38.1	46.8	30.2	29.1
1902	69.2	61.3	46.1	39.9
1903	72.0	72.5	59.0	32.8
1904	62.0	64.0	50.3	35.0
1905	50.0	66.8	43.4	39.0
1906	39.0	78.1	32.6	37.4
1907	12.5	33.7	17.5	22.0
1908	50.0	63.6	45.0	31.1
Average	50.8	63.1	42.3	33.4

MONTANA.

At the Montana Agricultural Experiment Station, at Bozeman, in a 5-year trial the Swedish Select oat gave yields inferior to those of a number of other varieties. In addition to the low-lying rich soil and excellent climate the oat plats had the advantage of irrigation. Other trials by farmers in other parts of the State were made under conditions of "dry farming" without irrigation. Results are available only for the period from 1900 to 1905, inclusive, and through some oversight the Swedish Select variety was not sown at the experiment station in 1902. This happened, too, to be a year of enormous yields, one variety, the Wide Awake, yielding 172.5 bushels per acre. For the remaining years in this period from 1900 to 1905 the yield of the Swedish Select, compared with five other varieties, was as follows:

Yield to the acre of the Swedish Select oat compared with that of five other varieties grown at the Montana Agricultural Experiment Station during 1900 *and* 1901 *and from* 1903 *to* 1905.

Variety	1900	1901	1903	1904	1905	Average	Weight per bushel	Period of growth
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bushels*	*Pounds.*	*Days.*
Progress	93.2	92.4	127.5	137.4	112.5	112.6	41.6	118.0
White Danish	99.5	92.4	114.4	135.2	138.8	116.1	41.1	118.0
Wide Awake	79.6	94.3	120.0	141.7	115.6	110.2	41.9	117.0
Scotch	79.6	95.2	97.5	153.4	112.5	107.6	41.5	116.0
Swedish Select	93.2	100.2	99.4	133.4	108.8	107.0	44.1	111.5
Bland's White	95.6	87.7	113.4	113.1	112.5	104.5	40.6	122.0

The Swedish Select oat stands fifth in the list in yield. These varieties only were grown in 1905. For the years 1900, 1901, 1903,

and 1904 the following other varieties made an average yield greater than that of the Swedish Select, while several fell below it:

	Bushels.
Mogheda	109.8
American White	109.2
American Beauty	107.9
Archangel	106.9

It will be noted in above table that the Swedish Select oat stands much above the others in weight per bushel. It is also four days earlier than any other variety. Only one variety out of fifteen, the Badger Queen (not grown in 1905), weighed more than the Swedish Select, the average weight of the former for four years being 44.5 pounds per bushel.

SOUTH DAKOTA.

Next to Wisconsin, more attention has been given to the Swedish Select oat at the South Dakota Agricultural Experiment Station, at Brookings, than at any other point. Here this oat has been grown throughout the 10-year period from 1899 to 1908, but in 1902 no results were reported because of the damage by wind, and in 1903 all varieties were entirely destroyed by hail. Therefore, actual results are available for only 8 years out of the 10.

During the period mentioned, 1899-1908, many varieties of oats were grown, a number of them having just been introduced by the writer from Russia and other foreign countries. In the following table is given the yield per acre obtained with some of the best sorts, only two of which, the Swedish Select and the Tobolsk, were grown each of the eight years.

Yield to the acre of the Swedish Select oat compared with that of other varieties grown at the South Dakota Agricultural Experiment Station from 1899 to 1901 and from 1904 to 1908.

Variety.	1899.	1900.	1901.	1904.	1905.	1906.	1907.	1908.	Average.	Number of years grown.
	Bush	*Bush*	*Bush*	*Bush*	*Bush*	*Bush*	*Bush*	*Bush*	*Bushels.*	8
Swedish Select	41.65	22.7	59.0	70.0	45.3	61.6	24.1	25.0	43.67	8
Tobolsk	35.50	24.3	57.0	55.6	40.6	47.5	5.0	21.8	35.91	6
Sixty-Day	......	......	65.0	69.6	80.0	61.6	24.4	59.2	59.96	5
Lincoln, No. 151	......	......	......	50.7	24.3	42.2	14.1	17.6	29.78	4
White Schoenen, No. 153	......	......	......	46.8	20.6	19.4	......	8.4	23.8	4
Bavarian, No. 150	......	......	......	46.8	30.2	32.7	......	13.4	30.77	5
Banner, No. 160	......	......	......	54.7	35.2	42.7	8.1	2.5	28.64	5
American Triumph, No. 162	......	......	......	52.7	30.5	45.5	10.9	4.3	28.78	5
American Beauty, No. 163	......	......	......	55.6	28.7	43.8	10.3	5.0	28.68	5
North Finnish Black	......	......	....	65.0	35.7	40.8	5.0	20.6	33.42	5
Holstein Prolific, No. 158	......	......	......	55.6	22.8	44.4	11.9	5.4	28.02	5
Wide Awake No. 154	......	......	......	51.7	24.1	35.0	11.9	12.5	27.04	5
Abyssinian, No. 155	......	......	......	54.7	25.6	37.2	14.4	16.2	29.62	5
Columbus, No. 156	......	......	......	58.6	31.9	42.8	17.8	15.0	33.22	5
Golden Beauty, No. 159	......	......	......	56.6	27.5	42.4	13.8	6.2	29.3	5
Belyak, No. 10624	......	......	......	28.0	37.5	42.8	9.1	26.8	28.84	5

It is seen that the Swedish Select variety yielded better than any other oat except the Sixty-Day, which gave a much better average for the years it was grown, 1901-1908. During these same years

the Swedish Select average was 47.5 bushels, while 59.96 bushels was the Sixty-Day average. The latter is already to a large extent replacing the former in eastern sections of the State. Until recently the Swedish Select has been by far the most popular oat and is still largely employed in the drier districts. It is an attractive oat, because of the size and weight of its kernel and its usual freedom from discoloration. The Tobolsk and the North Finnish Black, standing third and fourth in rank, respectively, are also northern varieties adapted to cool, dry seasons and high plains.

At the branch experiment station at Highmore, S. Dak., the Swedish Select oat was grown during the period from 1903 to 1909, inclusive. Here the conditions are usually severe foı oat growing, and this variety gave good results compared with others, as is shown in the following table:

Yield to the acre of the Swedish Select oat compared with that of other varieties grown at the branch experiment station at Highmore, S. Dak., from 1903 to 1909, inclusive.

Variety.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	Average for 4 years (1906-1909).	Average for 5 years (1905-1909).	Average for 7 years (1903-1909).
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Swedish Select	38.1	54.4	55.0	65.0	30.8	32.9	36.6	41.3	44.1	44.7
Sixty-Day	24.1	41.3	64.1	*43.3	31.5	47.5	28.8	37.8	43.1	40.2
Kherson	....	....	....	69.7	28.7	45.8	21.9	41.5	....	....
Red Algerian	....	....	60.3	49.1	21.8	32.8	23.4	31.8	37.5	....
Belyak	....	....	52.5	55.6	26.5	21.3	22.8	31.6	35.7	....
Golden Beauty	....	....	....	60.3	26.5	27.5	17.2	32.9	....	....
American Beauty	....	....	....	47.8	35.3	25.3	20.3	32.2	....	....
American Triumph	....	....	....	49.4	31.5	26.3	20.3	31.9	....	....
Columbus	....	....	....	52.5	25.0	28.1	16.3	30.5	....	....
Lincoln	....	....	....	45.6	30.6	29.7	15.6	30.4	....	....
Danish	....	....	....	46.3	26.8	30.3	15.0	29.6	....	....
Canadian	....	....	....	52.2	23.4	30.3	12.5	29.6	....	....
Holstein Prolific	....	....	....	48.8	26.2	22.5	17.8	28.8	....	....
Abyssinian	....	....	....	50.9	25.3	25.0	12.8	28.5	....	....
Wide Awake	....	....	....	42.5	24.6	28.9	10.6	26.7	....	....
White Tartar	....	....	....	44.7	26.2	25.0	4.7	25.2	....	....

***This yield of the Sixty-Day oat is not comparable with any of the others for that year, as it was grown after sorghum, while all the others were grown under better conditions. This is proved by the fact that the Swedish Select was duplicated on the sorghum ground and made there only 42.8 bushels per acre. However, using this figure the 7-year average, 41.5 bushels, thus resulting for the Swedish Select is still somewhat larger than that for the Sixty-Day.**

Taking an average of all trials in each case, the Swedish Select variety gave the best yield, though the Kherson yielded a trifle better in the 4-year average, 1906-1909. The yield of the Swedish Select at Highmore in 1903 was not quite as good as the average oat yield throughout the State (38.6 bushels), because of severe drought in that district. Highmore is considerably west of the one hundredth meridian, where it is ordinarily very dry for oats. On the other hand, in 1905 (a wet season) and 1908 the Sixty-Day exceeded the Swedish Select in yields. With reference to the crop of 1903, an authority wrote as follows: It is worthy of note that at the driest time the Swedish Select oat appeared to be the most drought-resistant grain on the farm, with the Minnesota No. 6 Manchuria barley a close second. This appearance was borne out by the yields at harvest time. The Swedish Select oat has received the greatest attention in Wis-

consin, though also grown to a large extent in South Dakota and Montana. It has been shown that the 10-year average yield of this oat at the Wisconsin Agricultural Experiment Station was 8½ bushels greater than the average of all other varieties. Also, calculating the averages of the highest yielding varieties for several different periods, in which all varieties were grown every year, there is a constant difference in yield of about 12 bushels per acre in favor of the Swedish Select in comparison with the next highest variety. Taking the mean of these two determinations, or, rather, reducing the latter one, we can probably safely assume a constant average increase in yield of at least 10 bushels per acre for the Swedish Select over that of other varieties in these tests.

As all varieties were grown under the same conditions it is reasonable to infer that the Swedish Select oat will show the same superiority over ordinary kinds when grown throughout the State.

SIXTY-DAY AND KHERSON OATS.

History.—Most of the varieties of oats now grown in the northern half of the United States came originally from northern Europe or have been produced from varieties from that section. Our great central valleys are, however, subject to high summer temperatures not found in the more equable climate of northern Europe, and for that reason the varieties of oats from Germany, Sweden, and similar European sources have not been altogether satisfactory in our corn belt. Conditions more nearly approaching our fertile prairie sections are found in the chernozëm or "black-earth" district of southern Russia. This district is one of wide extremes of heat and cold, with rather low rainfall. The hot summer and rich soil make it comparable with the corn belt, and though the rainfall is lower it is readily seen that varieties of grain of value there are likely to prove desirable over a large portion of the United States. The Nebraska Agricultural Experiment Station secured seed of an early variety of oats from this section in 1896. This seed was sent out under the name Kherson, that of the district from which it came. It was quite widely distributed in Nebraska, but for several years was little known outside that State. In March, 1901, an importation of a similar variety was received by the United States Department of Agriculture from Mr. C. I. Mrozinski, of Proskurov, in the Podolia government of Russia. This province lies just west of the Kherson government and its climatic and soil conditions are much the same. This variety was received as "Sixty Day" and has been widely distributed under this name. It closely resembles the Kherson and is practically identical with it, although under the same conditions there is sometimes considerable variation in yield.

The two varieties Sixty-Day and Kherson are so similar in appearance that the same description may be applied to both. The plant is a vigorous but not rank grower, usually less inclined to lodge than varieties with coarser straw. The head, or panicle, is loose and spreading, bearing a large number of grains. The grain is small to medium in size, long, and rather slender, but, under favorable conditions, plump and well filled.

The color of the Sixty-Day and the Kherson oats varies with the locality. In the corn belt the grain is a deep golden yellow, while farther north and in drier sections it is much paler, becoming almost white in the extreme West and Northwest. The hull is very thin and the weight per bushel usually high. The crop ordinarily reaches maturity in 90 to 100 days, or about 10 days earlier than most of the varieties commonly grown.

Desirable and Undesirable Characters.—The principal objections urged by farmers against this class of oats are the yellow color and the small size of the berry. In some markets there is a discrimination in favor of white oats of 1 or 2 cents a bushel, but by far the larger portion of our oat crop is fed on the farms where produced, and yellow oats are just as good for feeding as those of any other color. On the other hand, on account of its thin hull this particular type of oats is higher in feeding value than are most other varieties. In tests made some years ago in which samples of a number of varieties from Wisconsin, North Dakota, Kansas, and Montana were examined, the Kherson and the Sixty-Day oats ranked highest in the proportion of kernel to whole grain in every case. The highest percentage recorded was 78.07, from a sample of Kherson grown in Wisconsin in 1905, while the lowest was 54.86, from a sample of white oats grown in the same State the following year. Kherson and Sixty-Day oats grown under exactly the same conditions as this latter sample showed more than 70 per cent of kernel. The average of 12 samples of these two varieties showed 73.3 per cent of kernel, while 39 samples of other varieties showed 69.2 per cent. On this basis, where ordinary oats are worth 50 cents a bushel for feeding, the Sixty-Day and the Kherson are worth 53 cents. Frequently the difference in favor of the latter varieties is even greater. The North Dakota Agricultural Experiment Station says that on account of its thin hull the Sixty-Day is worth 4 or 5 cents more a bushel for feeding than some other varieties.

In some sections the Kherson and the Sixty-Day oats mature at the same time as winter wheat, and for that reason are not popular, though by some the fact that they can be harvested and thrashed at the same time as wheat is considered an advantage. This early thrashing enables the grower to market his oats ahead of the main crop, sometimes at much better prices than can be obtained later. In the spring-wheat district or where large acreages of oats are grown, they extend the length of the harvest season.

On account of their short straw and early maturity they are among the best varieties for use as nurse crops. Their yield of straw is less than that of most other varieties, so that where a large quantity of roughage is desired this type of oats is not to be recommended. The straw is of excellent quality, however, and is readily eaten by stock. Less seed can be used than of the large-grained varieties. Seeding at the rate of 2 bushels to the acre is sufficient where 2½ bushels is the ordinary rate.

Adaptability to Various Sections.—While neither the Kherson nor the Sixty-Day oat has yet been tested over the entire oat-growing

area, they have been distributed widely enough to give a good idea of their adaptability.

COMPARISON OF SIXTY-DAY AND KHERSON OATS.

An opportunity for a comparison of the merits of the Sixty-Day and the Kherson oats is afforded by the figures given in the following table. In this table strictly comparable tests from fourteen stations are reported. The duration of the tests varies from two to seven years and averages four years:

Comparison of the yields of the Sixty-Day and the Kherson oats in fifty-five tests at fourteen agricultural experiment stations for periods averaging four years.

Station	Number of years tested.	Sixty-Day.	Kherson.
		Bushels.	*Bushels.*
Lafayette, Ind	5	44.86	41.66
Madison, Wis	4	58.30	56.40
St. Anthony Park, Minn	4	58.03	56.74
Ames, Iowa	5	45.20	55.10
Edgeley, N. Dak	4	37.60	37.10
Brookings, S. Dak	3	48.40	49.10
Belle Fourche, S. Dak	2	36.30	36.40
Lincoln, Nebr	7	52.50	55.30
Manhattan, Kans	6	41.79	41.43
McPherson, Kans	3	35.38	32.60
Amarillo, Tex	3	24.37	18.61
Bozeman, Mont	5	78.80	82.00
Philbrook, Mont	2	52.40	50.50
Akron, Colo	2	38.65	45.60
Average	....	48.26	49.13

(*Oats References.*—F. B. 395, 420, 424, 436; B. P. I. Cir. 30., 1909; Bul. 182; Div. Botany 23; Ala. A. E. S. 137; Tuskegee Nor. & Ind. Inst. 8; Ga. A. E. S. 44; U. Ill. A. E. S. 136; Purdue U. A. E. S. 14, 50, 117, 139, 149; Iowa Agr. Col. E. S. 45, 55, 96; Kans. St. Agr. Col. E. S. 13, 29, 42, 54, 63, 74, 144, 153, 166; Ky. A. E. S. 99; La. A. E. S. 111; Mich. St. Agr. Col. E. S. 28; U. Minn. A. E. S. 81, 90; Mo. Agr. Col. E. S. 15, Cir. 46, 1910; Mont. Agr. Col. E. S. 84; U. Neb. 82; N. H. A. E. S. 145; N. Mex. A. E. S. 8; N. Dak. Agr. Col. E. S. 36, 75; Ohio Agr. E. S. Cir. 88, 1909, Bul. 101, 138; Pa. St. Col. A. E. S. 39, 76; S. C. A. E. S. 7; U. Tenn. Agr. E. S. 2, 1890; Utah Agr. Col. E. S. 56; Wyo. A. E. S. Rpt. 1900.)

BARLEY.

Barley requires a richer and more porous soil than wheat. It does best on well-drained loam soils, though the volcanic soils of the Northwest also give good results. This crop can be produced on sandy loam, but on this type of soil it is more susceptible to unfavorable climatic conditions than on silt or clay loam. In any case the soil should contain considerable humus and be in good physical condition.

Heavy, undrained clays are not adapted to the growing of barley. The roots of this plant are comparatively weak and do not penetrate such soils as readily as those of wheat. Soils of this type

are especially undesirable for winter barley, for while a stand may usually be obtained, the crop is likely to be injured by the alternate freezing and thawing of winter and early spring. Owing to the fineness of the soil particles, heavy clays are much more subject to washing than are the more porous loams. This washing exposes the roots of the young plants and is another cause of the failure of winter barley on this type of soil.

Well-drained, well-fertilized, gravelly clay soils have in some instances given good results in barley production. Loose, sandy soils, while easily prepared, are often deficient in plant food, while their inability to retain moisture makes them of doubtful value for the production of this crop. Though the moisture-retaining capacity may be largely increased by the addition of stable or green manures, the results will not be satisfactory as those obtained on fertile loams. The greater ability of the loam to retain moisture insures better and more uniform germination during periods of drought, an important factor in the success of the crop.

Fertilizers and Manures.—Barley is rather shallow rooted as compared with other cereals. As careful field observations show that the greater portion of the feeding roots are confined to the upper 6 inches of soil, the plant food should be near the surface and in an available form. This is one of the reasons why barley responds so readily to commercial fertilizers.

Barnyard manure is the best fertilizer for barley, if it is available in sufficient quantity and is applied at the right time. It is superior to commercial fertilizers because in addition to the three essential elements—nitrogen, phosphorus, and potassium—it contains vegetable matter which improves the physical condition of the soil. On the loamy soils of the West the addition of vegetable matter is not so important, but on the clay soils of the South it has much to do with the success of the crop. Compact soils are made open and porous by the addition of barnyard manure, while the vegetable matter absorbs and holds moisture and prevents the drying and baking so common on such soils. It has been demonstrated, however, that plowing under coarse barnyard manure just before sowing barley seldom gives good results. Its effect on the physical condition of the soil is generally injurious, making it too open and porous. If plowed under some time before seeding, the plant food becomes available, the soil has time to settle, and the results are beneficial.

Where the soil is deficient in plant food and humus, the plowing under of clover, alfalfa, cowpeas, or other green-manure crops some time previous to the sowing of barley is of benefit.

Where barnyard or green manures are not available, it is sometimes necessary to use commercial fertilizers in order to produce good crops of barley. The quantity and kind of fertilizer to be used depends on the requirement of the crop and the fertility of the soil. If the plants lack vigor and are of poor color, though climatic and other conditions are favorable, it is an excellent indication of a lack of nitrogen and phosphorus. In favorable seasons, if the grain fails

to fill properly, the necessity of increasing the quantity of phosphates and potash is indicated. Frequently a complete fertilizer containing the three important elements, nitrogen, phosphorus, and potassium, may be necessary. Barley usually has large, heavy heads and consequently requires a stiff straw to prevent the plant from lodging. The fertilizer should, therefore, contain a higher percentage of potash and phosphorus than of nitrogen.

Rotation.—In the greater portion of the United States barley has no fixed place in the rotation, but is generally sown without regard to the preceding crop. The market demand and the necessity for feed are the factors which usually influence the acreage.

The preceding crop has considerable influence on the yield of barley. At the Tennessee station it was found that winter barley after cowpeas were turned under yielded 56 bushels, while after corn the yield was only 41 bushels. This indicates that on clay soils in the Southern and Central States, where the supply of humus is usually deficient, a different rotation is necessary from that practiced on the rich prairie or alluvial soils where barley, after corn, potatoes, or wheat, usually gives good results.

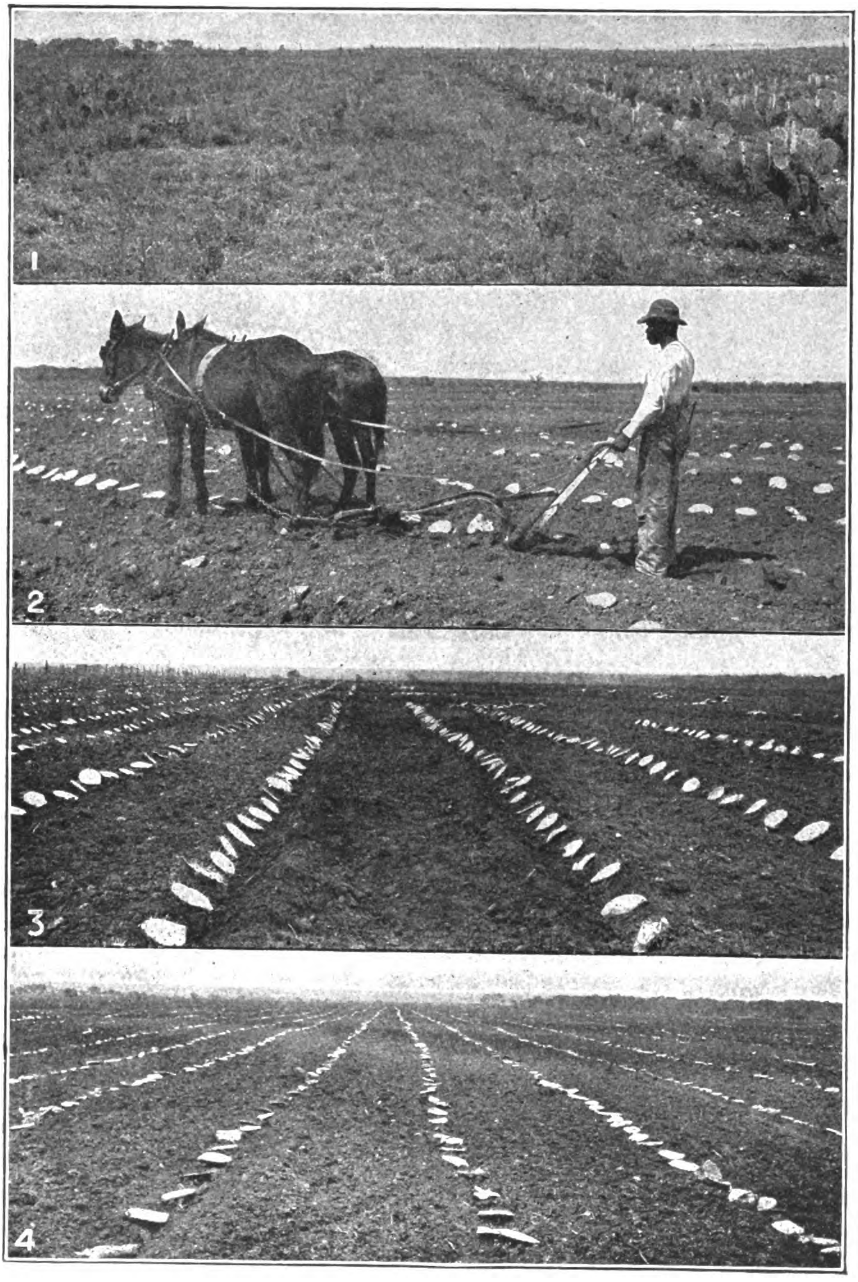
A rotation which has given satisfaction in Minnesota consists of one year of corn; one year of barley, grass seed being sown with the grain; meadow and pasture as long as desired. Flax may take the place of corn, or may immediately precede it. A rotation planned to keep up the soil fertility consists of corn two years; barley one year, with grass or clover sown with it; hay two years, or meadow one year, and pasture one or more years. The grass land should be manured before breaking for corn.

In the Dakotas barley frequently follows wheat, the wheat stubble being disked and the barley drilled in. Where corn and oats are grown it may follow either of these crops. It generally does best, however, when following corn or where a leguminous or green-manure crop has been plowed under the preceding year. On many farms wheat is grown almost continuously, barley being grown only where a change of feed is desired, or when the land becomes weedy.

In Kansas, where alfalfa is grown, corn frequently follows that crop, while barley or other small grains follow corn. In Montana, where the growing of small grain predominates, a rotation which includes two years of clover followed by three crops of small grain, in the last of which clover is again sown, has given good results.

Effect of Barley on the Land.—Experiments conducted at the South Dakota station indicate that barley as a crop is exhaustive to the land. A crop of barley of 40 bushels or 1,920 pounds of grain and 2,200 pounds of straw removed from the soil 54.14 pounds of nitrogen, 20.93 pounds of phosphoric acid, and 49.35 pounds of potash, a total of 124.42 pounds. Comparing this with other crops, we find that a 30-bushel crop of corn, weighing 1,680 pounds, removed a total of 113.99 pounds of these three elements; a 15-bushel wheat crop, weighing 900 pounds, removed 59.11 pounds; and a 45-bushel oat crop, weighing 1,440 pounds, removed 97.77 pounds.

The comparative quantities of the elements removed from the



Prickley Pear Experiments.

(See pages 587-590.)

soil by the grain and the straw of a 40-bushel barley crop were found to be as follows: Nitrogen, 28.99 and 25.15 pounds; phosphoric acid, 15.17 and 5.76 pounds; and potash, 9.22 and 40.13 pounds, respectively. From these figures it can be seen that the grain removed 1.1 times as much nitrogen and 2.5 times as much phosphoric acid as the straw. The straw, however, removed more than 4 times as much potash as the grain.

It has been estimated that under California conditions a 40-bushel crop of barley removes 46 pounds of nitrogen from the soil, or 1.15 pounds to the bushel. A 60-bushel crop of oats removes 55 pounds of nitrogen, while a 35-bushel crop of wheat removes 59 pounds. In South Dakota it was found that a 40-bushel crop of barley removed 1.35 pounds of nitrogen per bushel, or 0.20 pound more than in California.

Drought Resistance and Water Requirements.—With the exception of the hooded and hull-less varieties, barley is not generally considered drought resistant. It is most affected when the plants are small and when the heads begin to fill. This accounts for the shortness of the straw following a dry spring and the poorly filled heads after a dry period during heading. The hooded and hull-less barleys will generally produce a crop with less rainfall than will spring wheats, with the possible exception of those of the durum type.

Preparation of the Land.—Barley is grown over such a wide area and under such a diversity of conditions that definite rules for its cultivation can hardly be given. The thorough preparation of the seed bed is essential under all conditions, as on this depends a large part of the success of the crop. Plowing should be done the fall previous or a considerable time before seeding. This allows a complete settling of the soil and improves its water-holding capacity. Many failures have resulted from planting barley on newly plowed ground, especially when a dry season followed. The crop seldom does well on newly broken sod; but when sod land is to be planted best results will be obtained if it is broken shallow and laid flat rather than set on edge, as is commonly done. Breaking should be done while the grass is fresh and green, as decomposition then sets in rapidly and the vegetation and roots soon decay. Plowing under vegetation when the plants and roots are tough is injurious, as their slow decay renders the soil too open.

No soil should be plowed when very wet. The shearing action of the plow upon the bottom of the furrow is likely to form an almost impervious layer or "plowpan" by compacting the soil particles. Unless the depth of plowing is varied from year to year this layer is likely to injure the growth of corps that follow. By gradually changing the depth of plowing each year new soil is brought to the top and mixed with the surface soil without injuring its yielding capacity.

In some portions of the United States the ground is seldom plowed for barley where it follows a cultivated crop, but is simply

cross or double disked and harrowed. When the soil is in good physical condition good crops may be obtained by this method.

Sowing the Seed.—The proper selection of barley for seed is important, but is a factor in the production of the crop which is often neglected. Where the grain is very small or imperfect the vitality is generally poor. Even though these small grains germinate, the plants produced are weak and may not survive an unfavorable season. If they mature, they generally produce grain of inferior quality. The lateral grains in the six-rowed barley during unfavorable seasons are light and chaffy and will not germinate, hence they should be removed and only plump seed sown. The stand will be considerably improved by the removal of this inferior seed. It is generally true that large, plump seeds contain larger germs than small ones and produce stronger and more vigorous plants, which rapidly develop large, healthy root systems. This rapid development of the root systems aids them to resist drought or other unfavorable conditions. Where a well-established root system is developed early in the growth of the plant, the maximum quantity of moisture and plant food for its successful development is supplied. On the Great Plains, where barley is injured by the blowing of the soil, a plant with a strong root system can better retain its hold than a weak-rooted one.

If, owing to unfavorable weather conditions during the ripening period or after harvest, the seed is of doubtful viability, several lots of 100 grains each should be taken from different parts of the seed bin and tested in plates of moist sand or earth, or between sheets of moist blotting paper. If less than 90 grains of each lot show vigorous germination, better seed should be obtained or the quantity of seed sown per acre increased.

Barley should be sown as soon as danger from severe frosts is over and the soil is sufficiently warm and dry to prepare a good seed bed. This date varies in the Northern States from April 1 to May 15, according to the locality and season. In the central portion of the United States planting begins as early as March 1 and continues until the middle of April. In the Southern and Central States where winter barley is sown, seeding between September 15 and October 15 gives best results. Where the crop is liable to attack from insects, October 1 to 15 is preferable. If intended for pasture, however, the seeding should be done early in August. In the Southwestern States seeding is most successful when done in November, December, and January. In California the seeding of barley extends from November to March, according to the elevation, location, and season.

The best method of sowing barley is in drills 6 or 8 inches apart. This method insures even distribution of the seed and places the grain at the proper depth for germination, thus promoting a perfect stand. Grain in drills can withstand a dry season better than that sown broadcast, as the plants develop a deeper root system, enabling them to absorb more plant food and moisture from the soil. Where the crop is drilled there is a better opportunity for air and sunlight to penetrate, an important factor during a moist sea-

son. When barley is sown broadcast and harrowed in, it is covered to various depths and germinates unevenly. While a good stand may be obtained, the plants from seed not sufficiently covered frequently fail to survive a long dry period following spring sowing, or a severe winter after fall sowing.

Little attention is generally paid to the depth at which barley is sown. It varies from a fraction of an inch when sown broadcast to several inches when sown with a drill. The proper depth depends on the moisture and the physical condition of the soil. Usually, seeding at a depth of 2 to 3 inches will give best results. On compact soils the former depth is sufficient.

Cultivation.—Barley, as a rule, is not cultivated, though in the semiarid regions or in seasons of drought in the more humid ones barley sown in drills will be benefited by cultivation with a spike-toothed harrow or weeder. This loosens the surface soil, aids in holding the moisture, and destroys small weeds. Barley sown broadcast, however, can not be cultivated without considerable loss.

Irrigation.—In the Rocky Mountain States considerable barley is grown under irrigation. The proper quantity of water to apply to obtain the best results is a question of considerable importance. Where the supply is abundant, farmers are apt to use more water than is necessary. Surface indications are not safe guides to follow in the irrigation of barley, as a soil may appear to be dry on the surface and yet contain sufficient moisture for the growth of the crop.

Harvesting.—Barley ripens in the Southern States from May 1 to June 1. In the Central States it generally matures in June and July, and in the Northern States in July and August. In the Pacific States the time of ripening varies from May 15 to September 1, according to the elevation and the time of seeding. Unfavorable weather conditions may extend the season, but usually a few days' difference in seeding causes but a slight variation in the time of ripening.

Barley requires more judgment in harvesting than almost any other cereal. If harvested too early the appearance and value of the grain are injured by shrinkage. If allowed to become overripe the heads bend over and shatter badly during harvesting, while in humid regions the grain becomes discolored.

The hardness of the grain when pinched between the thumb and first finger will indicate when the crop is ready to harvest. If the grain can just be dented with the nail, it is in the hard-dough stage and should be cut immediately. In unfavorable seasons, when the grain ripens unevenly, it is better to cut when most of the heads are ripe, even though there is some loss from shrinkage. If the grain is intended for brewing purposes it should not be cut too early, as it increases in value until the grain is dead ripe. Barley should not be cut when wet with dew or rain, as the bundles dry out slowly.

If weather conditions are favorable, it is best to let the bundles dry before shocking. They should then be set up in oblong rather than round shocks, as the oblong shocks allow better ventilation. Capping the shocks is usually practiced, but they should not be

cappend when wet. In sections of the West where high winds prevail, barley is usually shocked without capping, as the caps blow off and the quality of the grain in such sheaves is injured by lying on the ground.

Barley while in the shock is frequently injured by heavy rains Moisture not only discolors the grain, but if excessive may also cause it to sprout. Opening the shocks is the only remedy. The common method is to scatter the bundles on the ground, but as there is danger that the grain in contact with the soil will absorb sufficient moisture to cause further injury, the method practiced in Germany and by farmers in some localities in the United States is recommended. When the shocks are opened the first bundle is laid flat on the stubble; the second and succeeding bundles are then laid across the middle of the preceding ones, the butt ends resting on the ground and the heads projecting beyond the bundles upon which they rest, the object being to keep the grain off the ground. By lapping the bundles in this way the heads are kept off the ground and are exposed to the action of the air, so that they dry out quickly. Even though rained on while in this position, they will soon dry and will be damaged less than if lying on the ground.

Barley should not be stacked until the grain has at least partly cured in the shock, especially when the bundles contain weeds or grass. Insufficient curing in the shock may cause heating, discoloration, and germination during the sweating process in the stack. If the grain is fully ripe when cut it can be stacked in a few days. In the semiarid regions some growers stack as soon as the crop is cut.

The general opinion among the most successful growers in the West is that stacking gives better results both in color and soundness, two important factors in regulating the price of barley. Barley is generally more difficult to stack than wheat or oats because of the shortness of the straw. As it does not shed water as readily as wheat or oats, it is better to stack in slender, circular stacks, rather than in the extremely large ones commonly seen in the West.

If the grain stands in the shock for some time, the cap sheaves often become discolored from rains or heavy dews. If these are thrashed with the bundles which have been protected, the discolored kernels will be mixed with the brighter grain and the market value of the whole lessened. If the cap sheaves are thrashed separately the discolored grain may be kept for feeding on the farm, as color does not materially affect the feeding value; but when barley is long exposed to the weather some loss is occasioned by the leaching out of some of the soluble constituents of the grain.

Care should be used in thrashing. If the concaves are set too close many grains will be cracked or broken and the awns will be broken off too close to the grain, thus considerably reducing its viability and market value.

Storing the Grain.—Barley should be carefully housed after thrashing, as it rapidly absorbs moisture and is easily influenced

by changes in temperature. If stored in damp bins it becomes musty, and as odor is one of the factors which influence the market value, dampness and mustiness should be avoided. Dampness is also likely to injure the germination of the grain, either for malting or for seed. When barley is well cured before thrashing and is stored in cool, dry bins, it passes through the sweating process and remains bright, clean, and sweet. If the grain becomes damp in any way it should be shoveled over several times or changed to another bin in order to dry it thoroughly. A prominent grain grower in Maryland dries damp or poorly cured grain by forcing a current of air through it from the bottom of the bin by means of a fan driven by a small engine. The fan is usually run for a day or two, but after the current is established the fan can be stopped. This method avoids the necessity of rehandling the grain when it becomes damp.

Varieties.—In recent years there has arisen a considerable rivalry between two-rowed and six-rowed barleys, and there has been much discussion as to the relative merits of these two classes of barleys. It is well known that the two-rowed barleys are generally used in Germany and are considered much better than the six-rowed varieties. In this country the six-rowed varieties have been in favor. This is no doubt partly owing to the fact that the six-rowed barleys have until recently been given more attention by the farmers, and have therefore obtained a foothold in this country. It is only recently, after a thorough investigation of many barley varieties, that the difference in adaptation of these two groups of barleys to different portions of the country has been ascertained. This natural adaptation of the two groups to different areas appears to clear the situation nicely, at least from the agricultural standpoint. As there seem to be good arguments from the commercial standpoint for the production of either class of barleys there is apparently no good reason why the farmer should not cultivate the particular barley which gives him the best acre yields.

In the largest barley-growing district, the six-rowed barleys, Manchuria, Oderbrucker, and Odessa, do best in Minnesota, Wisconsin, Illinois, Iowa, and Nebraska, while in North Dakota and South Dakota the two-rowed varieties, such as Hannchen, Swan Neck, Chevalier, and Hanna, give better results. Six-rowed barley is principally grown in western New York and in Michigan, Ohio, and Indiana. In Kansas, Oklahoma, Texas, and the Southern States generally the most profitable variety to grow is the six-rowed Tennessee Winter. In the high altitudes of the Rocky Mountain States hooded barley is the most profitable type. In Utah and Idaho the six-rowed type, both spring and winter, gives the best results, Utah Winter being the most profitable variety. In the Pacific States the six-rowed varieties, Bay Brewing and California Feed, are the most common, although some excellent barley of the two-rowed varieties, Chevalier and Hanna, is also produced.

The hooded and hull-less barleys have proved successful in the semiarid regions of the West, where they are superior to any.

Numerous tests of varieties of barley have been made at the various State agricultural experiment stations. Oderbrucker, a six-rowed variety, produced the highest yield at the Wisconsin station. At the Minnesota station Manchuria and Russian were the best six-rowed varieties; Hannchen, Chevalier, and Primus are the best two-rowed. At the North Dakota station Russian was the best six-rowed barley and Moravian the best two-rowed. At the Edgeley and Dickinson substations the two-rowed varieties led in yield, while at Williston the six-rowed were best. The best six-rowed barley yielded slightly more than the best two-rowed at the South Dakota station. At the Highmore substation and the Bellefourche Experiment Farm the two-rowed varieties yielded best. At Manhattan, Kans., Tennessee Winter barley led in yield and Manchuria was the best spring variety. At McPherson, Kans., the six-rowed spring varieties yielded best. At the Montana station the largest feed returns were obtained from the hulless varieties. The two-rowed barleys were superior to the six-rowed at the Wyoming station. At Akron, Colo., and Modesto, Cal., these two groups differed little in yield. At Nephi, Utah, the six-rowed barleys are the most profitable.

BARLEY CULTURE IN THE SOUTHERN STATES.

Winter Barley.—This is cultivated in the South for grain, hay, and pasture. At present the most popular variety for grain production is Tennessee Winter, a six-rowed, bearded barley which was selected and improved by the Tennessee Agricultural Experiment Station and has been widely distributed in recent years by the Office of Grain Investigations of the Bureau of Plant Industry. A similar variety known as Union Winter is grown at the Tennessee station and sometimes gives a larger yield than Tennessee Winter. Union Winter is also grown at the Virginia Agricultural Experiment Station.

Spring Barley.—Bearded barley as a spring grain crop is not generally adapted to the Southern States, as has been demonstrated at several of the agricultural experiment stations and experimental farms. At the Maryland Agricultural Experiment Station a comparative test was made between the two-rowed and six-rowed spring barleys and the six-rowed winter barley. The two-rowed spring barley yielded at the rate of 24.4 bushels and the six-rowed spring barley at the rate of 29.2 bushels, an average of 27.7 bushels for the spring varieties. The average from three half-acre plats of winter barley was 50.5 bushels, or 22.8 bushels more than that from the spring varieties. The yields of the spring varieties in this experiment were far in excess of those of spring barley obtained elsewhere.

In 1908 nearly two hundred varieties and selections of two-rowed and six-rowed and of bearded and hull-less barleys were sown by the writer on the Arlington Experimental Farm. The soil and climatic conditions were favorable, and good growth was made by many of the varieties. The greater portion, however, failed to mature grain, but would have made excellent hay.

Hooded barley can be grown as a spring grain crop on the clay and loam soils of the Piedmont region and higher elevations of the

South. The yield, however, is usually not as satisfactory as that of the Tennessee Winter variety. At Mountainville, Tenn., spring hooded barley was sown broadcast on river bottom land on February 1 at the rate of 1½ bushels to the acre. The crop was ripe on May 15, and gave a yield of 40 bushels per acre. This large crop was no doubt due to the care used in the selection and preparation of the soil and seed.

Soils.—While barley can be grown upon most of the soils of the South, a fertile, well-drained clay or loam will produce the best grain crop. These soils will also give better results when barley is grown for winter pasture. The strong, vigorous growth necessary for producing a heavy hay crop is also made on the heavier soils. For hog pasture or for fall or spring soiling the crop can be grown on the lighter soils.

Fertilizers.—The appearance of the growing crop is a good indication of the kind of fertilizer needed. If the plants make a rapid growth and are of a rich green color it indicates that there is sufficient nitrogen in the soil to make a crop. If the growth is slow and of a poor color it indicates a lack of nitrogen and possibly a sour soil. If the plants make a good growth but the stems are weak and the heads small and not well filled, the need of phosphoric acid and potash is indicated. Many of the soils of the South are deficient in nitrogen and phosphoric acid. Potash is generally less needed than the two former, although on worn-out soils a complete fertilizer is necessary. Where cowpeas and green manures are plowed under and considerable humus is formed, the purchase of nitrogen, which is the most expensive of these three elements, can be largely avoided, thus reducing the cost of fertilizers.

Sowing the Seed.—The time of seeding will have to be regulated according to the locality, the elevation, and the purpose for which the crop is to be used. If intended for pasture, barley should be sown at least two weeks earlier than if intended for grain, so that the plants may become firmly established before pasturing commences. For a grain crop the seeding in southern Pennsylvania, Maryland, and northern Virginia should be done not later than September 25. Farther south and at lower altitudes seeding is usually done in October and November. A safe rule is always to sow the barley before the seeding time for wheat, as barley is less likely to be injured by insects than wheat.

The rate of seeding barley must be determined by the fertility of the soil and the purpose of the crop. For a grain crop it should be sown with a drill at the rate of 8 pecks to the acre. On poor soil the seeding should be less than on more fertile soil. For pasture, hay, or soiling purposes the higher rate of seeding can be used on fertile soils.

There is no doubt that drilling in the seed will give the best results. Winter barley should be drilled in deeply, leaving the furrows rough after the drill. In case of heaving, due to freezing and thawing during the winter and early spring, the young plants are less likely to be injured than when the soil is made level. So many

failures have resulted from broadcasting the seed of winter barley that it is not considered wise to sow it in that way. However, as some may desire to try winter barley who do not have a drill, the following directions are given:

Prepare a good seed bed, at least 4 inches deep, and sow evenly from 10 to 12 pecks of seed to the acre. Harrow deeply so that the seed is well covered, as this is the secret of success with winter barley. Cross harrowing will distribute the seed more evenly. Fertilizers should be added to give the plants a strong, vigorous start.

(Harvesting, Thrashing, etc., are the same as treated generally under Barley.)

(*Barley References.*—F. B. 427, 443; B. P. I. Cir. 5; Div. Botany 23; Tukegee Nor. & Ind. Inst. E. S. 8; Colo. Ag. Col. E. S. 40; Ga. A. E. S. 44; Iowa Ag. Col. E. S. 45, 55; Kans. St. Ag. Col. E. S. 127, 144, 166; Mich. St. Ag. Col. E. S. 28; Mont. Ag. Col. E. S. 84; N. H. Col. A. E. S. 145; N. Mex. A. E. S. 8; N. Dak. A. E. S. 75; Utah Ag. Col. E. S. 56; U. Wyo. A. E. S. 83, Rpt. 1900.)

RYE.

As rye grows vigorously in the poorest soil, it should logically be placed upon well drained and light land, both to escape the water and to make the best use of the soil. The best crop can be produced, however, on medium soil in good fertility. Soil containing too much nitrogen, as the result of applications of fertilizers, is not desirable, as it tends to produce a rank growth of straw, with the consequent liability to lodging. Rye usually succeeds a manure crop, such as corn or potatoes.

Rye is divided into two classes, spring and winter. Only winter ryes are of any importance in the United States.

This crop can be sown in the standing corn at the last cultivation in July and will afford considerable pasturage for all stock. It is often thus sown either alone or mixed with rape for lambs or sheep being fattened for market. If seeded on especially prepared ground the crop will come on much earlier and give considerable more fall feed. Seed at the rate of 1½ bushels per acre. In pasturing cows on rye the change from other feeds to rye should be gradual to avoid possible taint of milk. Rye can also be grown as a forage crop for early spring use. It is becoming more general as a cover crop, for which purpose it is valuable.

The grain of rye is darker in color than that of wheat, but is otherwise similar in appearance. Rye flour differs from wheat flour in flavor, the liking for the one or the other being a matter of preference. It differs, however, in another way and in an important particular—its gluten has not the same elastic, tenacious quality and does not yield so light and well-raised a loaf. Although this fact and its dark color make it less popular than wheat, it is second in importance as a breadstuff. It is more easily raised than wheat, especially in cold countries, and therefore generally has a lower market value. When it is milled entire, as it usually is, it contains more protein than wheat flour, but is probably less completely digested.—

(F. B. 65, 389; Cir. 36, 1911, Dept. Ag.; Mich. St. A. E. S. 28; U. Minn. A. E. S. 81, 90; N. Dak. A. E. S. 75.)

EMMER.

Emmer has been grown to a considerable extent as a profitable field crop in portions of this country for 15 to 20 years and was known to northwestern farmers probably as early as 1875 or 1880. In recent years its cultivation has greatly increased. There are both spring and winter varieties.

Use of Incorrect Names for Emmer.—This grain is incorrectly called by various names. Even in certain reports of results of experiments with emmer it is sometimes called spelt. The names "spelz," "speltz," and "spiltz" are also often used. The most common word thus wrongly used is "speltz," which does not even exist as a legitimate word in any language. What is meant is the German word "spelz," which is spelled differently and which is translated "spelt" in English. True spelt, however, differs as much from emmer as pears differ from apples.

One of the characteristic qualities of this cereal, which commends it at once to cultivators, is its ability to make a good crop with almost any condition of soil or climate. Almost all varieties are drought-resistant, the winter varieties are usually quite winter hardy, and the damaging effects of rains upon grain at harvest time in wet districts do not usually occur with this cereal. It will thrive also on poor lands, in stony ground, in forest regions, and on the prairies. The attacks of rusts and smuts do not affect it as they do ordinary wheats. There are, however, certain conditions of soil and climate under which it always gives the best results. In general the best emmer is produced and in largest quantities in prairie regions having a dry climate with short hot summers.

From the trials so far made of emmer both at the experiment stations and on farms, as well as the plat experiment of this Department, one may draw the following conclusions with respect to its success in cultivation in this country: (1) It is most successful in the Great Plains region, particularly the northern portion, in the Palouse country, and in northern portions of the irrigated districts; (2) in other parts of the country, however, it will often compare well with other crops, and is especially able to escape damage from continued wet weather at harvest time; (3) it stands up well in the field; (4) it is usually very resistant to the attacks of leaf rust, smuts, and other fungi; (5) it is very resistant to drought; (6) in districts where it is otherwise adapted it gives excellent yields; (7) true winter varieties, of which there are not many, resist rather hard winters.

Cultivation.—Very little need be said on the cultivation of this grain. It is probably the least exacting of all cereals in methods of cultivation. It will occasionally be found to be of particular advantage as a sort of intermediate crop when the soil has become exhausted by the growth of other more exacting crops. In the North the usual methods of cropping with spring grains should be followed. As with other grains, it will of course give better results on ground plowed the previous summer. A summer fallow, however, is not re-

quired, and would simply be wasteful. The seed should always be drilled, and at about the same rate per acre as for oats. It is of the greatest importance to sow early. The grain will stand a great deal of spring frost.

Trials by Farmers.—Winter emmer has not yet been given a very wide distribution. Nevertheless, a number of farmers have had opportunity to grow it, and wherever careful attention has been given and the winters are not particularly severe results have usually been good. George W. Oster, of Osterburg, Pa., grew winter emmer in 1908-9 and obtained a yield of 45 bushels per acre. No rust, smut, or insects of any kind affected the crop. R. T. Bennett, of Wadesboro, N. C., obtained a yield of about 25 bushels per acre in 1907, when wheat on the same farm yielded 12 bushels per acre. In that locality, of course, winter emmer is winter proof. Mr. Bennett made the comment that "stock prefer the emmer to oats and no weather is too frosty for it." A. L. Dunlap, of Lupton, Mich., obtained a yield of 12 bushels per acre in 1910, when the preceding fall from seeding time until winter was very dry. He states that the crop is "very good; better than oats." It weighed 40 pounds per bushel. D. L. Davis, of Zenia, Cal., grew winter emmer during the year 1909-10, sowing broadcast at the rate of 70 pounds per acre. A yield of 31 bushels per acre was obtained. Mr. Davis remarks in a report that "it is a great drought resister. It stood the drought equal to rye. It is the surest crop I have found in eight years' trial of grain here. The straw is soft. It fills well, stands up good, and yields better than barley or rye." In February, 1911, Mr. Davis wrote: "I have sold every bit of the emmer. I have not even a sample on hand. The people come for 25 miles for seed."

As showing the adaptation of this crop to dry districts it is interesting to report that S. A. Figart, of Johnson, Stanton County, Kans., in the extreme southwestern part of the State, obtained a yield of 60 bushels per acre in the summer of 1907 from a seeding of only half a bushel per acre. The crop was drilled and was no doubt given good attention in other respects. The same season the other crops of Mr. Figart yielded as follows: Corn, 30 bushels; wheat, 5 bushels; white spelt (true spelt, no emmer), 15 bushels. It should be remarked that a crop of this kind giving such yields is of the greatest importance in this district, where the conditions are such that stock raising must be practiced to a large extent, and emmer has already proved to be an excellent stock feed, easily taking the place of barley, rye or oats.

In Germany, Russia, and other southeastern countries of Europe emmer is often used as human food. In Russia such use is chiefly in the form of breakfast foods. In other countries it is used to a considerable extent in bread making. In the United States emmer is not yet used for human food, but it may be so used before many years, as it is known to furnish an excellent breakfast food.

Emmer has usually been found a fairly good food for stock, though in some cases barley or oats appear to be better. To decide accurately between emmer and the other crops, however, one must

consider the greater possibility of obtaining a crop of emmer in the drier districts.

It is important to know, if possible, the amount of grain per acre by weight that emmer will furnish compared with other cereals that may be used in stock feeding in order to determine which crop it is most profitable to grow for that purpose when quality is also taken into consideration. The North Dakota station presents a tabular statement of yields for eight years in pounds per acre of emmer, barley, oats, common wheat, and durum wheat, here reproduced as follows:

Comparative yields in pounds per acre of emmer, barley, oats, and wheat for eight years at Fargo, N. Dak.

Kind of grain	1898	1899	1900	1901	1902	1903	1904	1906	Average
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Emmer	2,338	2,291	980	2,518	2,469	2,101	1,976	800	1,945
Barley	2,336	2,360	844	1,946	2,780	2,079	1,704	840	1,877
Oats	2,400	2,436	1,058	1,933	1,988	2,378	2,054	1,610	1,969
Wheat	2,212	1,552	1,379	1,719	1,590	2,694	984	1,560	1,711
Durum wheat	....	1,948	1,167	1,997	1,943	2,833	1,410	1,500	1,835

It is seen that in acre yield emmer exceeded all other cereals except oats, which exceeded emmer only slightly. The fact should be considered that these results were obtained while using spring emmer in the comparison. As in all other cases where winter grains are compared with spring grains, winter emmer would no doubt give much better yields.

Value of Winter Emmer as a Field Crop.—Winter emmer will be found of much value in a field-cropping system in several ways. Since it is used for stock feeding in the same way as oats or barley, it will be of much use in localities where those crops do not give good results. In a number of the Central, Southern, and Eastern States, where oats do not do so well as in the North and where winter oats would not be hardy, there is considerable demand for a winter cereal to be used as stock feed. This crop should exactly fill that demand. It will ripen earlier than oats, yield better, and may furnish a considerable quantity of fall and winter pasturage when the ground is in condition for turning stock into the field with safety. It will withstand extremes of climate much better than any other cereal. For a large part of the United States, therefore, it may be considered a general-purpose crop so far as climate is concerned, but it will not withstand the winter in the Northern States east of the Rocky Mountains.

In the Rocky Mountain and Pacific coast region winter emmer will be particularly valuable as a stock feed in dry farming, for the reason that often the drought is too great for ordinary crops of oats and barley, but not sufficient to prevent the production of a fair crop of emmer. It can, therefore, be used as a parallel crop to winter wheat, the emmer being grown for stock feeding and the winter wheat for sale. The best results with winter emmer so far have been obtained in intermountain districts.—(F. B. 139,

466; Iowa Ag. Col. E. S. 55; Kans. St. Ag. Col. E. S. 123, 144; S. Dak. A. E. S. 71, 81, 86.)

BUCKWHEAT.

A moist, cool climate is most favorable for buckwheat, although the seeds will germinate in a very dry soil, and considerable heat in the early stages of growth is an advantage. High temperatures in the period of seed formation, especially hot sunshine following showers, is usually disastrous to crop yield, causing blasting of the flowers. The same effect is attributed to strong east winds. The yield is much reduced by drought during this period. Buckwheat will mature in a shorter period than any other grain crop, eight or ten weeks being sufficient under favorable conditions. It is thus well adapted to high altitudes and short seasons, but its period of growth must be free from frosts as the plants are very sensitive to cold.

Soil.—Buckwheat will grow on a wide range of soils, but those of a rather light, well-drained character are best suited. It will give fair yields on soils too poor or too badly tilled to produce most other crops and seems to be less affected by soil than by season. It is not desirable, however, to attempt to grow buckwheat on very rich land, as under such conditions the crop frequently lodges badly with results even more serious than occur when other grain crops go down, as the plant has no method of rising again. This ability to produce fair crops on poor soils and under indifferent cultivation has led to buckwheat being often considered the poor farmer's crop, and to poor and unskilled farmers being dubbed "buckwheaters." The crop lends itself well to the farmer who lacks capital to secure timely labor or wait for returns on investments in tillage and fertilizer. It may be planted after the rush of spring work is over; it may be resorted to as a substitute for spring crops or meadows that have failed and it brings quick return for investment in fertilizers One farmer is reported as saying: "I like to raise buckwheat because it is the only grain for which I can buy fertilizer on a 90 day note and pay for it out of the crop it makes." Buckwheat, however, responds to more generous and intelligent treatment and deserves to be held in higher esteem than it usually enjoys.

Since buckwheat is not usually planted till the last of June, owing to pressure of other work, the land too often is not plowed till just before seeding and then receives hasty and indifferent fitting. This allows little time for sods and other organic matter to decay and become incorporated with the soil and capillarity is not re-established between the subsoil and the seed-bed. Under these conditions, the development of the crop is slow and if drought ensues disaster is the result. Early plowing of the land so as to allow of several harrowings at intervals of two weeks and a thorough settling of the soil nearly insures the maximum crop the land is capable of producing. If early plowing is impracticable, then the greater attention should be given to a thorough fitting of the seed bed.

Fertilization.—Stable manure is not usually applied to land intended for buckwheat, but is reserved for more exacting crops. Moderate applications of manure, however, on poor soils result in largely increased yields. Buckwheat when grown on poor land, responds well to moderate dressings of even low grade fertilizers.

Seeding.—The amount of seed used per acre in seeding buckwheat varies from three to five pecks but is usually four pecks. It may be sown with the ordinary grain drill or broadcasted and harrowed in. The time of seeding varies in different localities, but in New York and Pennsylvania is the last week in June or the first week in July. To avoid hot weather while the grain is forming, it is desirable to sow as late as possible and have the crop well developed before severe frosts occur. Buckwheat begins to bloom before the plants have nearly reached full growth and continues blooming till stopped by frost or the harvest. Hence there will be at harvest time on the same plants mature and immature grain and flowers. It is sought to cut the crop just before the first hard frost. Much of the immature grain will ripen while lying in the swath or gavel.

Harvesting.—Buckwheat is rarely harvested with the self-binder, but may be cut with the hand-cradle or the dropper-reaper. To avoid the shelling and loss of the more mature grains it is preferably cut early in the morning while damp from dew or during damp cloudy weather. It is usually allowed to lie a few days in swath or gavel when it is set up in small independent shocks or stooks. It is not bound tightly by bands as are most cereal grains, but the tops of the shocks are held together by a few stems being twisted around in a way peculiar to the crop. This setting up is also usually done when the crop is damp to avoid shelling of the grain.

The unthreshed crop is not often stored in barns or stacked but is threshed direct from the field. Formerly much of the threshing was done with the hand flail, in which case it is necessary that the work be performed on a dry airy day so that the grain will shell easily. If threshed by machinery, neither crop nor day need be so dry. It is usual to remove from the thresher the spiked concave and put in its place a smooth one, or a suitable piece of hardwood plank. This is to avoid cracking the grain and unnecessarily breaking the straw. The pedicels bearing the seeds are slender and these as well as the straw, when dry, are brittle so that the grain threshes much easier than the cereals.

Rotation.—Buckwheat usually has no definite place in the rotation of crops. This is chiefly due to its being used as a substitute for meadow or spring-planted crops that have failed. The poorer lands and the left-over fields are usually sown to buckwheat. While buckwheat seems not to be materially affected by the crop that precedes it, on the other hand it is reported to affect unfavorably certain crops when they follow it. Oats and corn are said by many to be less successful after buckwheat than after other crops. That this is so has not been established by any experiment station.

Buckwheat leaves the soil in a peculiarly mellow, ashy condition. In the case of rather heavy soils on which it is desired to grow potatoes, this is a decided benefit and in some localities the practice of preceding potatoes by buckwheat, for the purpose of securing this effect, has come to be common. The following rotation is sometimes recommended for such soils: clover, buckwheat, potatoes, oats or wheat with clover seeds. The first crop of clover is harvested early and the land immediately plowed and sown to buckwheat as a preparation for potatoes.

Varieties.—There are three principal varieties of buckwheat grown in America—the Common Gray, Silver Hull, and Japanese. The seed of Silver Hull is slightly smaller than the Common Gray —the color is lighter and of a glossy, silvery appearance. The Japanese is larger than the Gray, of somewhat darker color and there is a tendency for the angles or edges of the hull to extend into a wing, making the faces of the grain more concave. The plant of the Japanese variety is a somewhat larger grower than the others, the fresh stem has a green color and the flowers seem not to be quite so subject to blasting from hot sunshine as the others. On this account it is recommended in some localities to sow the Silver Hull and Japanese varieties mixed, it being said that the later and hardier Japanese will shade and protect the others from hot sunshine, thus avoiding blasting and securing a larger zone of seed-bearing straw than is furnished by either sort alone, a larger yield resulting. The Silver Hull variety has a red stem and branches more freely than the others. The leaves also are smaller.

Each of these varieties has produced largest yield in certain tests. It seems that there is adaptation of variety to soil or climate or, perhaps, to weather conditions that has not yet been worked out, that produces these contradictory results. However, the yielding quality of the Japanese variety is usually conceded to be superior to that of the others.

Formerly the flouring qualities of the Japanese variety were pronounced by many millers to be inferior to the other sorts and not infrequently the price of Japanese buckwheat was five or ten cents per bushel less than the others. In some localities this condition still prevails; in others the reverse is true. In parts of Seneca Co., N. Y., in recent seasons the millers have offered a bonus of five cents per bushel for the Japanese variety. Whether this change in the estimate of the variety is due to improvement in the quality of the grain due to acclimatization, or to better adaptation of the milling methods to the variety has not been ascertained.

Consumption.—Formerly a considerable part of the buckwheat was used for animal food, only enough flour being manufactured to meet the requirements of the rural districts during the winter season Of late the demand for the flour in the cities has been such that most of the grain is ground for flour and less of the flour is consumed in the rural districts

Buckwheat flour is whiter than that made from wheat and has a peculiar mealy feel to the hand that enable one readily to dis-

tinguish it from wheat flour. The first flour on the market after harvest brings a high price, but the price rapidly declines as the supply increases. The grain must be well dried and the grinding performed in cool dry weather to secure best results in milling. The yield of flour per bushel of buckwheat is usually about twenty-five pounds, though twenty-eight or more may be secured if the grain is plump and very dry. The middlings, a by-product of the flouring process, is much sought by dairymen as food for dairy cows on account of its high content of protein. The hulls have little or no value. Sometimes they are ground and used as an adulterant for black pepper. Buckwheat grain is much relished by poultry and has a reputation of being of special value in egg-production. In recent feeding experiments this reputation is scarcely sustained.

Enemies.—The buckwheat crop is unusually free from interference from weeds or plant-diseases. It starts so quickly and grows so rapidly that most weeds get no chance to make headway against it. In fact, buckwheat is one of the best crops for cleaning land by smothering out weed growths. Wild birds as well as domestic are fond of the grain and when abundant sometimes cause considerable loss. No insect or fungus troubles have been sufficiently destructive to attract much attention.—(Cornell U. A. E. S. 238.)

POP CORN.

In earlier times pop corn was very commonly grown in small quantities on many farms and in gardens for home consumption for it has long been a favorite food or food accessory with Americans. In recent years there has been a tendency to depend on the larger growers for pop corn and this crop is now raised in some regions to a very large extent.

As regards the culture of pop corn it may be said in brief that it is much the same as for sweet corn. When grown on a large scale it is drilled in and is not planted in checks. It is usually harvested by hand and marketed on the cob or shelled.

An explanation of the popping of corn is furnished as the results of experiments which lead to the conclusion that the great enlargement of the kernel and change in form and texture is caused by an expansion of moisture in the starch cells. Each individual cell is a miniature sealed bomb, the walls of which are sufficiently dense to retain the moisture until it has been converted to steam under pressure.

If the residual moisture is sufficient and the conversion into steam is uniform and rapid, the greater number of cells of which the kernel is composed will be exploded and the result will be a large, dry, mealy mass of converted cornstarch. If the corn is old and dry it will at best only split open from a number of cells near the center of the corn kernel. If the application of heat be made slowly it is possible to dry the kernels of corn, parch, and even char them without rupturing the outer coat in any way.

It was also noted that at the base of the kernels, or at the point of attachment to the cob, the cells were less compact and were seldom, if ever, ruptured by the generated steam. It is from

this point, too, that the kernels of corn appear to dry most rapidly. The bearing of these observations on the theory that popping is caused by an explosion of steam is found in the fact that pop corn invariably bursts first at the densest portion of the kernel, and never at or near its base or point of attachment.

When old and dry corn was soaked for twelve hours and then dried for an equal time it did not pop well. If kernels were allowed to dry for twenty-four hours longer the resulting kernels of popped corn were found not only to be very large, light, and flaky, but had absolutely no suggestion of toughness.—(F. B. 202.)

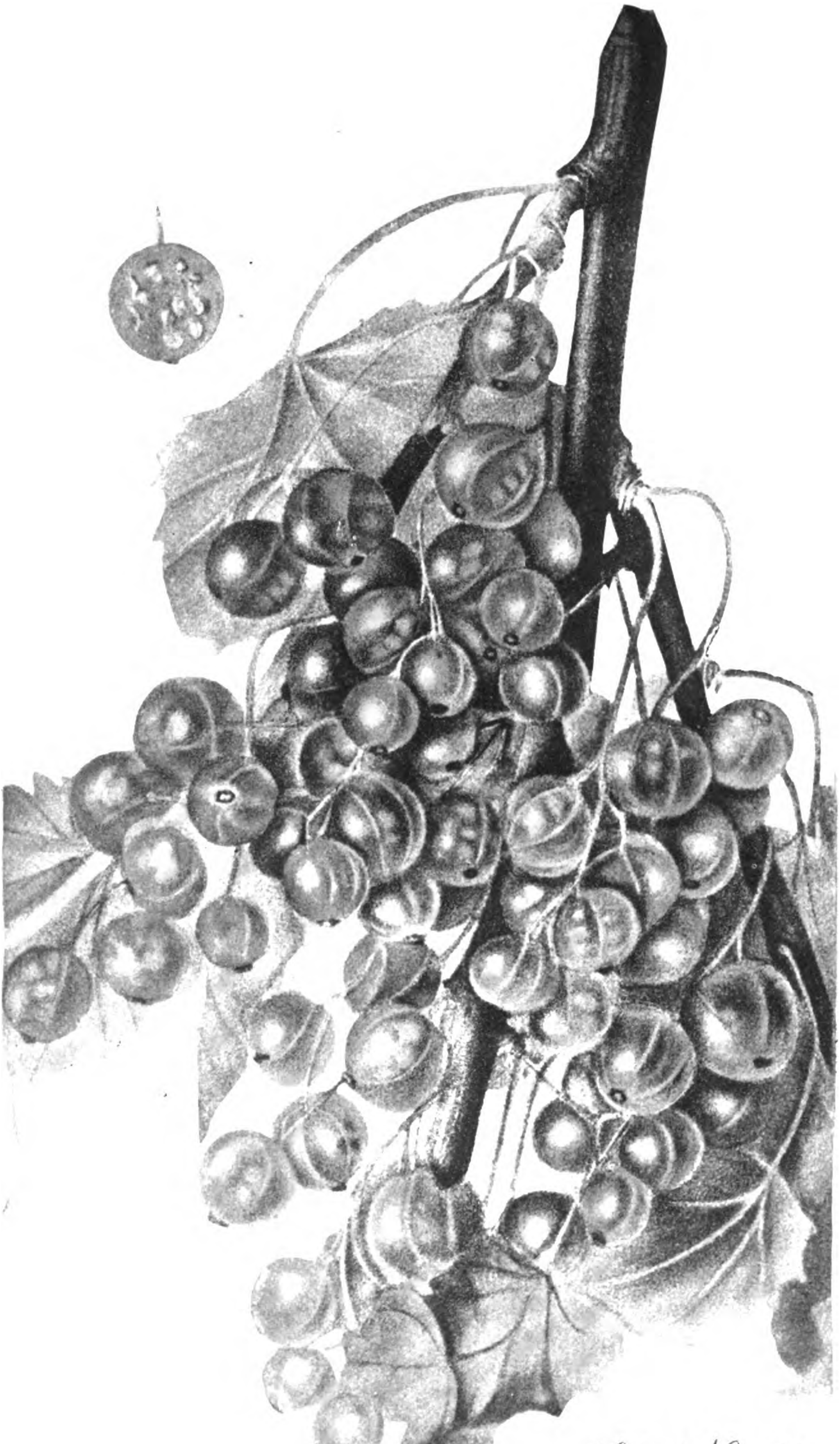
CANADIAN FIELD PEAS.

The term Canadian field peas, or, as it is more commonly expressed, "Canada field peas," is used with much latitude in this country. Ask a pea grower in the United States as to the variety of seed which he sowed and the almost invariable answer given is: "I sowed Canada peas." That may mean that he grew any one of nearly one hundred varieties. The answer is significant. It implies, first, a great lack of knowledge with reference to varieties on the part of those who grow peas; and, second, that much of the seed used in the United States is, or was at one time, imported from Canada, although we have large areas unrivaled in their adaptability to the growing of peas.

Various Uses.—No other grain crop, except perhaps oats, can be devoted to so great a variety of uses. The grain is possessed of a relatively high feeding value, and the same is true of the straw. As a pasture for certain kinds of live stock, peas may be made to serve an excellent purpose. The value of the crop for soiling and fodder uses is very great, and as a fertilizing crop peas are probably excelled only by clover.

There is no kind of live stock on the farm to which peas can not be fed with positive advantage, when they are to be had at prices not too high. They are not commonly fed to horses, since they can seldom be spared for such a use, but they make a good food for horses at work, and for colts during the period of development, if given as a part of the grain food. As a food for fattening cattle, peas are probably unexcelled. Much of the success which Canadian feeders have achieved in preparing cattle for the block has arisen from the free use of peas in the diet. During the first part of the finishing period they will be found peculiarly helpful in making beef, owing to their relative richness in protein, but they are also a satisfactory food at any stage of the fattening process. During the first half of the finishing period peas will be found superior to corn, but toward the close of the same, corn could probably be fed with greater relative advantage. Peas with oats or wheat bran make an excellent grain food for cattle that are being fattened. Speaking in a general way, peas should form about one-third, by weight, of the meal fed, but, as every feeder knows, the relative proportions of the meal used should vary somewhat as the season of fattening progresses.

Peas furnish a good food for milch cows. They have been



Diploma Currant.

found peculiarly beneficial for building up dairy cows when "out of condition," and for sustaining them in fine form, and they are also excellent for milk production. When given along with oats and bran to cows in milk, they may usually form from one-third to one-half of the grain portion by weight.

Peas, when fed with judgment and care, supply an excellent food for swine at all stages of development. They are well adapted to the sustenance of brood sows during the nursing period, for the reasons that have been given for their use with cows giving milk. With shorts, ground oats, or wheat bran, they may be made to form one-third to one-half the grain portion. Peas are superior to corn as a food for pigs at any time prior to the fattening season; hence they may be fed to them more freely, but in no instance should they form the sole ration before the finishing period begins During the fattening period peas are unexcelled when fed as the sole grain food They promote growth, while they fatten in excellent form, and they furnish a sweet, firm, and excellent quality of pork.

Along with oats, in, say, equal parts by weight, peas make a good grain ration for ewes in milk, and also lambs, more especially when the latter are for the early market. They may be used in greater proportion to fatten ewes quickly after the lambs have been weaned. When sheep are being fattened for the block in winter, no grain food can be fed which will be found more suitable than peas and oats. When fed to sheep or poultry, or to brood sows in winter, peas do not require to be ground. For all other live stock it is considered advantageous to grind them, but in some instances they are soaked for feeding to swine. When so prepared they are frequently fed to growing swine when on pasture, and in order to insure due mastication they should be fed on a floor.

When pea straw is well cured, it is more relished by horses, cattle, and sheep than the straw of rye, wheat, barley, or even oats. Animals which have never eaten it may not take kindly to it at first, but soon learn to eat it with a relish. The value of the straw, however, depends largely upon the stage at which the crop is harvested, the mode of harvesting, and the perfection of the curing process.

Peas are more commonly used as a pasture when sown in conjunction with some other kind of grain, and since they are more easily injured by the trampling of live stock than other grain crops, it is usual to pasture them only with sheep and swine. When sown with oats or barley, peas make a good summer pasture for sheep. The greatest objection to such pasture is in the earliness of the season at which it is produced. Of course, it may be grown later, but will not produce so abundantly.

Peas grown in conjunction with some other kinds of grain are of great value as a soiling crop, owing, first, to the larger yields obtained (from 10 to 20 tons per acre may be expected on average soils); second, to the high nutritive value of the food, combined with its palatability; and, third, because of its timeliness. This

crop is ready as soon as the spring grasses begin to fail, and it may be made to continue in season until corn is ready. It is excellent for all kinds of live stock, but especially valuable for dairy cows.

The advantages resulting from growing peas in conjunction with other grains for fodder are many. They include the following: First, larger yields may be obtained from growing these mixtures than by growing the grains used in them singly, and the increased yield extends to the grain as well as to the straw; second, when fodder is thus grown it may be fed directly to the animals—it is not necesary, usually, to chaff it with the cutting box, and the labor and cost of first thrashing and grinding the grain are avoided; third, a pasture crop, such as rape or rye, may follow the same season. Such a system will be found most helpful as an aid in destroying weeds. As the relative areas adapted to growing these foods far exceed those adapted to growing peas for the grain, it is probable that in the near future they will be most extensively grown for soiling and fodder uses.

Like all leguminous crops, peas have the power of extracting nitrogen from the air and of depositing it in the soil for the use of other crops which follow. Hence it is that the soil on which a crop of peas has been harvested is richer in nitrogen than before the peas were sown upon it. Peas could thus be made to bring more nitrogen to the soils of this country every year than is now purchased annually by the farmers at a cost of millions of dollars.

Besides the nitrogen that it brings to the soil, the value of a crop of peas in fertilizing and also in improving the mechanical texture of the soil is greatly enhanced when it is grown as a green manure. When soils become so impoverished that good crops can no longer be grown on them, they may be quickly renovated and also cleaned by plowing under a pea crop preceded by winter rye. The rye should, of course, be sown in the autumn, and plowed under in the spring when the heads begin to appear. The peas should be sown immediately, and in turn plowed under when in bloom. Ground thus treated would be fertilized and cleaned in one season. Its tilth would be much improved, and its power to hold moisture would be greatly increased. To a farmer in the dry Northwest the benefit last mentioned would probably be the greatest. The high price of the seed in the past has stood seriously in the way of growing peas expressly for fertilizing uses.

That so valuable a crop should not have received more attention is indeed surprising. Chief among the reasons why it has been so neglected are the following: The lack of knowledge as to its merits, the difficulty in procuring seed, the want of suitable machinery for harvesting the crop, and the small measure of attention given to it, relatively, by the experiment stations. But little is known of the value of the pea crop by the average farmer.

Without any doubt there are vast areas in our favored country well adapted to growing peas as a grain crop. But the areas in which the crop can be grown for pasture, for soiling uses, and for

fodder are vastly greater, for where peas can be successfully grown as a grain crop they can also be grown for the other uses named.

Peas may be grown successfully on a variety of soils, but those designated clay loams, and which are well supplied with lime, are best adapted to their growth. However, good crops may be obtained on the stiffest clays. The potash element in these favors the growth of peas. Light, leachy sands, being deficient in moisture, do not produce enough growth of vine, and black, humus soils produce too much. Overwet soils are wholly unsuited to the growth of peas.

Theoretically, peas should not come after meadow or pasture, since they are capable of gathering nitrogen from the atmosphere, and in consequence do not need the sustenance furnished in the decay of grass roots so much as other grains; but in practice they serve the end of quickly subduing such soils by promoting the rapid decay of the sod and so putting the land in excellent condition for the crop which follows. Peas may be assigned any place in the rotation, but the aim should be to have a grain crop follow which is hungry for nitrogen.

In climates where peas can be grown at their best, namely, climates with low winter temperatures, the land for peas, as for nearly all grain crops, should be plowed in the autumn; but peas will do better than the other small cereals, relatively, on spring-plowed land. A fine pulverization of the soil is advantageous, but it is not so necesasry for peas as for other grain crops, since the pea is a hardy and vigorous grower.

Some writers advocate sowing the seed broadcast and then plowing it under. On heavy soils this method would bury the seed too deeply. On prairie soils it promotes the rapid evaporation of soil moisture. On fall-plowed lands the better plan is to prepare the seed bed by pulverizing it, and then to sow the seed with a grain drill. When broadcasted and covered with the harrow only and rain follows, much of the seed will be exposed; but the writer has grown excellent crops on spring-plowed stiff clays from hand sowing without any previous pulverization. When such lands are carefully plowed, the peas fall in the depression between the furrow slices, and the subsequent harrowing covers them. Peas should be buried less deeply on stiff clays and more deeply on the soils of the prairie. The depth may be varied from 2 to 5 inches. The pea crop should be sown as soon as the soil can be worked freely; but it will suffer less, relatively, than the other grain crops if the sowing has to be deferred.

The quantity of seed required will vary with the character and condition of the soil and with the variety of seed sown. Rich and moist soils do not require so much seed as where the opposite conditions prevail. The amount of the seed sown should usually increase with the size of the pea. The quantities to sow per acre will vary from 2 bushels with the smaller varieties to 3½ bushels of the larger sorts. One great difficulty to be encountered in growing peas on prairie soils is the usual luxuriance of weed life, but this may be held in check by harrowing the crop before it ap-

pears above the surface. Harrows with teeth which may be set aslant are the most suitable for the work.

Until recent years the pea crop was harvested with the scythe or with the old-fashioned revolving hayrake. The first method is slow; the second shells out many of the peas, and it so covers the vines with soil as to render the straw practically unfit for use. Happily, a pea harvester has been introduced, by the aid of which the crop may be harvested speedily and in excellent condition on level soils. It is simply an attachment to an ordinary field mower.

The guards in front lift up the peas so that the knife can cut them cleanly. The cut peas fall behind the mower in a string-like row, or swath, and two men with forks bunch them and lay them aside out of the way of the horses. Three men and a span of horses may thus harvest 10 acres in a day. This attachment for harvesting peas is made in Canada, and those now in use in the West have all been imported. On rear-cut mowers a platform is sometimes used.

With this attachment, one man walks behind and with a fork throws the peas off in bunches. But the platform is of doubtful advantage unless the crop is evenly ripened, not too heavy, and free from standing weeds of strong growth. Where the land has been plowed in ridges, with furrows more or less deep between them, the working of the machine will be seriously interfered with.

It is usual to turn the bundles over once to facilitate drying while they lie on the ground. They require hand loading. The crop may be stored under cover or put into stacks, as with other grain, but it should be borne in mind that peas when in the stack do not readily shed rain, and therefore the stacks should be carefully topped out with some substance, such as bluegrass or native prairie hay. When the thrashed straw is preserved in stacks the same precautions are necessary.

Where only a small quantity is grown annually, and this with a view to provide seed to sow for pasture, soiling, or fodder uses, there is no better way of thrashing the peas than by using a flail or by treading them out with horses. The seed is not then broken. Where a large acreage is grown it is necessary to thrash peas with a thrashing machine, and the best work is done by using the "bar concave."

From this concave all the teeth should be removed except four. These hold the straw in check long enough to enable the cylinder teeth to beat out all the peas. The machine should not run at a high rate of speed. More or less of the seed is likely to be broken. The broken grains, however, may be nearly all removed when preparing the crop for seed or for market by using fanning mills suitably equipped with sieves. When the crop is varied for feeding uses the breaking of the peas does not, of course, lessen its value.—(F. B. 224; Colo. A. E. S. 40, 47; Mont. Ag. Col. E. S. 68; Wash. St. Col. A. E. S. 99; U. Wyo. A. E. S. 72, 84.)

COWPEAS.*

A system of agriculture without the use of a leguminous crop

* For illustration, see page 393.

tends to lessen the productivity of the soil and makes necessary large outlays for nitrogenous fertilizers. With a leguminous crop grown at frequent intervals, the productivity may be maintained or even increased. The cowpea is at the present time, and probably will continue to be, the most valuable legume for the entire cotton belt, and can be depended upon to succeed on practically all types of soils. It has been well said that the cowpea is to the South what red clover is to the North and alfalfa to the West.

It is safe to say that no one thing can add more to the agricultural wealth of the South than the more extensive growing of the cowpea. This will supply the southern markets with much of their hay, which is now shipped in from the North and West. It will tend to increase the production of live stock, which is very essential in securing the maximum returns in any system of agriculture; and it will go far toward keeping the soil in good tilth and maintaining its productiveness.

Growing Cowpeas for Seed.—The greater agricultural use of cowpeas has been seriously handicapped in late years by the high price of seed. Until the last few years cowpea seed has been almost entirely gathered by hand, though that harvested by machinery makes up an increasing percentage of the commercial seed each year. Cheaper seed will undoubtedly bring about an enormous increase in the culture of the crop.

Cowpeas when grown for seed or for combined seed and hay production are nearly always sown broadcast or with a grain drill. Occasionally fields are planted in rows and cultivated. Experiments generally prove that the largest yields are secured by planting in rows and cultivating, but in many localities this increased yield is not sufficient to offset the additional cost of cultivation.

The planting of cowpeas for seed production should always be thinner than for forage purposes. When grown in rows 24 to 36 inches apart one peck to a half bushel of good seed per acre is required. When the seed is broadcasted the quantity ranges from 3 to 6 pecks to the acre, depending on the soil, the method of seeding, and the size of seed. Heavy clay or light sandy soils require more seed than loam soils. If sown with a grain drill only about two-thirds as much as for broadcasting is required. Of the smaller seeded varieties, such as the New Era and the Iron, 2 or 3 pecks will give the best results; while of the larger seeded varieties, such as the Black, the Unknown, and the Whippoorwill, the quantities range from 3 pecks to 5 pecks to the acre, a bushel generally being the best amount to use. In most of the cowpea region planting for seed production should be rather late in the season, since late plantings as a rule give much better seed yields than early plantings. This is not the case, however, in Oklahoma and northern Texas, where early seeding gives the best yields, owing probably to the lighter rainfall. In certain sections near the Gulf, two seed crops in a season may be secured by growing in rows and planting the first very early.

Hand Picking.—The method of gathering seed by hand is the

only one practicable where the peas are planted in corn, which is a very common practice throughout the South The cowpeas are planted at the last cultivation of the corn and are nearly always ripe before frost The vines climb the corn stalks, so most of the pods are well above ground, which greatly facilitates gathering them. They are picked by hand into bags, and later flailed or run through a pod huller. The cost of hand picking ranges from 40 to 75 cents a hundred pounds of pods, or the picker is given one-third to one-half of the total quantity gathered. This method of harvesting naturally makes the price of seed high. Fields grown to cowpeas alone for seed production are often hand picked. The yield of seed in such cases is as a rule much larger and a larger number of pods can be picked in a day than when grown with corn.

Machine Picking.—The scarcity of seed and the difficulty of securing labor have resulted in the invention of several so-called pea pickers. These machines are intended to gather the pods from the vines in the field. The peas must be planted in rows for the most successful operation of a pea picker, and the entire plant must be ripe and dry before the machine will do satisfactory work.

Mowing and Thrashing.—Cowpeas for seed production are quite satisfactorily harvested with a mower. A bunching attachment has been used with excellent results. This gets the vines out of the way of the team, thus avoiding considerable loss of peas through trampling and crushing by the mower wheels. It also leaves the vines in a more desirable shape for curing, they being rolled into small windrows. The self-rake reaper is a very satisfactory machine for mowing cowpeas for seed, accomplishing even better results than the buncher on a mower, as the vines are left in bunches of very convenient size for curing and handling.

The bean harvester has been given careful trial in harvesting cowpeas for seed production, but it is not very satisfactory. Viny peas catch on parts of the machine and drag badly. There is also likely to be much soil worked into the vines, making the further handling difficult and disagreeable.

For seed production cowpeas should be allowed to mature a greater percentage of pods than when cut for hay. Half or more should be ripe before mowing, even at the expense of losing a part of the foliage. The vines should then be allowed to cure and become thoroughly dry, after which the thrashing may be done. The curing and drying may be done in the swath, cock, stack, or barn, as desired, weather conditions largely determining the method to be pursued. The hay or straw is of better quality if the curing and drying are done in the stack or barn, though, of course, the amount of work required is greater. It is a common belief that weevils do much less damage to seeds in the pods than to the thrashed seeds. On this account some growers store their crop and thrash it late in the winter or early in the spring. However, the unthrashed material requires much space for storage, and there is no effective way of combating the insects, while in clean stored

seed all insect life is readily destroyed by treatment with carbon bisulphid.

Cowpeas may be thrashed with an ordinary grain thrasher. In this case the riddles are adjusted for cowpeas and satisfactory screens are provided. The most essential point in thrashing cowpeas is to maintain a low and even speed of the cylinder, 300 to 400 revolutions per minute, while the rest of the machine should be adjusted to run at least as fast as for thrashing wheat or oats. Some operators prefer to have a greater clearance between the cylinder and concave spikes than for grain thrashing, while others do not think this an advantage. While expert operators sometimes do very satisfactory work with an ordinary grain separator, there are three important difficulties encountered: (1) Too many of the pods pass through with the straw unopened; (2) the machine is easily choked by the tangled vines wrapping around the cylinder; and (3) the percentage of cracked peas is usually large. To overcome these difficulties several modifications of thrashing machines have been devised so as to adapt them for handling cowpeas.

It is very essential in thrashing cowpeas that there be sufficient power to give a uniform speed to the separator. It is also highly desirable that the cylinder be kept uniformly full in order to get the best results, as runnig empty means an increase in the number of cracked peas.

The price of cowpea thrashers now on the market ranges from $300 to $600, exclusive of the engine. If the peas are stacked or put into a barn so they need not be thrashed immediately, one machine will be sufficient for 2,000 acres, as the crop from 20 acres can readily be handled in one day. As a rule only a moderate acreage of cowpeas for seed should be grown by any one farmer, as unfavorable weather may cause great difficulty at harvest time. It is very desirable to have enough cowpeas for seed grown in a community to justify the local ownership of a thrashing machine.

Cowpeas for Soil Improvement.—The beneficial results of growing cowpeas are due largely to the ability of the plants, like those of alfalfa and red clover, to take nitrogen from the air by means of the bacteria which live in the nodules on the roots. Cowpeas also improve markedly the physical condition of the soil. This, taken in connection with their ability to produce a crop quickly on even the poorer soils, makes the cowpea particularly valuable both as a catch crop and in regular rotations when utilized either for hay or seed production.—(F. B. 318; Del. Col. A. E. S. 46; Purdue U. A. E. S. 117, 139, 149; Iowa Ag. Col. E. S. 45; La. A. E. S. 111.)

PART IV

VARIOUS FARM PRODUCTS.

WEEDS.

If the weed is an annual, reproducing itself from the seeds only and dying root and branch each year, it may be subjected by preventing seed production. The seeds of many annuals retain their vitality for several years, so that if they once become abundant in the soil they are likely to germinate at irregular intervals, and thus cause trouble for a long time, even though no fresh seed is introduced. In this case merely preventing the production of seed will gradually reduce the quantity of weeds and will prevent any further spreading.

For permanent pastures, lawns, and roadsides this is often the most practical method, and it is quite sufficient if persistently followed. In cultivated fields the land thus seeded should first be burned over to destroy as many as possible of the seeds on the surface. It may then be plowed shallow, so as not to bury the remaining seeds too deeply in the soil. The succeeding cultivation, not deeper than the plowing, will induce the germination of seeds in this layer of soil and kill the seedlings as they appear. The land may then be plowed deeper and the cultivation repeated until the weed seeds are pretty thoroughly cleared out to as great a depth as the plow ever reaches. Below that depth—8 to 10 inches—very few weed seeds can germinate and push a shoot to the surface. A thousand young seedlings may be destroyed in this manner by the cultivator with less effort than a single mature plant can be destroyed, and every seedling killed means one less weed seed in the soil. Barren summer fallowing is often practiced to clear out weedy land by the method just described; but usually corn, potatoes, cotton, cabbages, or beets may better be grown, giving a profitable return for the extra cultivation. The best results can be obtained, of course, with crops that allow cultivation during the greater part of the season, and that do not shade the soil too much, as the direct rays of the sun heating the surface of the soil aid materially in the germination of many seeds.

As annual weeds usually thrive best in soil that has been broken but is not occupied, it is evident that broken land should not be permitted to remain idle. Abundant crops of annual weed seeds are matured every fall on potato and corn land and in stubble fields, where a profitable crop of crimson clover or winter oats or rye might have been grown. A little grass seed raked in on bare hillsides will often keep down annual weeds and will at the same

time prevent washing. Mowing the roadside two or three times during the summer will subdue the dog fennel and ragweed. Mowing the stubble about two weeks after harvest in grain fields that have been seeded to grass or clover will check the annual weeds and at the same time produce a mulch that is very beneficial to the seeding during the August drought.

Biennials.—Biennials, such as burdock, wild carrot, and bull thistle, store up nourishment in thickened roots during the first year of growth and during the second year they produce seed and die. Many species which are ordinarily true biennials will live three years, or possibly longer if seed production is prevented by mowing or cutting the stem above the crown of the root. In fact mowing or cutting off the main stem often induces it to branch out at the base and send up several stalks in place of the one. Cutting the roots below the crown usually kills them. If this work is to be done by hand with a hoe, grub hoe, or spud, as is often the case with bull thistles on new ground, it can be done most effectively and with least labor in the fall, during the first year of growth. The stools or rosettes of leaves, close to the ground, often give little suggestion of the prominent seed stalk to be grown the following year; but they are sufficient to indicate to the observing eye the presence of weeds. The roots at this time is more tender, and hence more easily cut than in the mature plant, and one does not have to strike so deep to be sure of killing it. In sod ground a spud—a tool like a chisel on the end of a fork handle may be used to much better advantage than a hoe for cutting thickened roots below the surface.

Biennial weeds are readily killed by cultivation such as is given to hoed crops, and the seeds may be cleaned out of the land by this method. The weeds of this class are usually most abundant in old pastures, along roadsides, and in waste places where the soil is seldom disturbed. The weeds must be destroyed in these places if the work of clearing the seed out of cultivated fields is to be made effective.

Perennials.—Perennial weeds reproduce themselves by seeds and also propagate by some form of perennial underground root or stem, as the crown-forming root of dandelion and ribgrass, the creeping root of Canada thistle and bindweed, the rootstock of couch grass and smartweed, the corm or solid bulb of nut grass and chufa, and the bulb of wild garlic. A few plants sometimes classed as noxious weeds have runners above ground, as Bermuda grass and cinquefoil. To destroy perennial weeds seed production must be prevented and the underground portion must be killed. Seed production may be prevented by mowing when the first flower buds appear, the same as in the case of annuals or biennials. In general, however, the following principles apply:

1. The roots, rootstocks, bulbs, etc., may be dug up and removed, a remedy that can be practically applied only in small areas.

2. Salt, coal oil, or strong acid applied so as to come in contact

with the freshly cut roots or root stocks destroys them for some distance from the point of contact. Crude sulphuric acid is probably the most effective of comparatively inexpensive materials that can be used for this purpose, but its strong corrosive properties render it dangerous to handle. Carbolic acid is less corrosive and nearly as effective. Arsenite of soda, a dangerous poison, is sometimes effective, applied as a spray on the growing weeds.

3. Roots may be starved to death by preventing any development of green leaves or other parts above ground. This may be effected by building straw stacks over small patches, by persistent, thorough cultivation in fields, by the use of the hoe or spud in waste places, and by salting the plants and turning on sheep in permanent pastures.

4. The plants may usually be smothered by dense sod-forming grasses or by a crop like hemp, buckwheat, clover, cowpeas, or millet that will exclude the light.

5. Most roots are readily destroyed by exposing them to the direct action of the sun during the summer drought, or to the direct action of the frost in winter. In this way plowing, for example, becomes effective.

6. Any cultivation which merely breaks up the root stocks and leaves them in the ground, especially during wet weather, aids in their distribution and multiplication, and is worse than useless, unless the cultivation is continued so as to prevent any growth above ground. Plowing and fitting corn ground in April and May, and cultivating at intervals until the last of June, then leaving the land uncultivated during the remainder of the season, is one of the best methods that could be pursued to encourage the growth of couch grass, Johnson grass, and many other perennial weeds.

Weeds Attracting Special Attention.—The influence of the Russian thistle agitation is plainly manifest in the attention given to certain weeds during recent seasons. Nearly one-half of those received at the United States Department of Agriculture with requests for naming and information belongs to species which are more or less prickly, and many of them have been mistaken for the Russian thistle. While but few complaints have been received in regard to the older well-known weeds, such as ragweed, dog fennel, and shepherd's purse, it is not to be supposed that these are becoming less abundant or less troublesome. People are generally familiar with these common weeds—too often so familiar that the weeds have come to be accepted as a matter of course and a necessary evil. Complaints about Canada thistle, couch grass, and Johnson grass indicate that these weeds, even when well known, can not be disregarded; but in general it is the new weed coming as an added evil that attracts attention.

Aside from the Russian thistle, the following ten species of weeds in the order given have received the most notice, according to the reports received at the United States Department of Agriculture:

Prickly lettuce (*Lactuca scariola*).	Dagger cocklebur (*Xanthium spinosum.*)
Bracted Plantain (*Plantago aristata*).	Chondrilla (*Chondrilla juncea*).
Horse nettle (*Solanum carolinense*).	Wild carrot (*Daucus carota*).
Buffalo bur (*Solanum rostratum*).	Wild oat (*Avena fatua*).
Spiny amaranth (*Amaranthus spinosus*).	False flax (*Camelina sativa*).

Prickly Lettuce.—A single average plant has been estimated to bear more than 8,000 seeds. The principal leaves on the stem have the unusual habit of twisting so that the upper part of the blade becomes vertical. They also point north and south, hence the name compass plant. The white, milky juice has suggested the name milk thistle. Both of these names are incorrectly used in this connection, as they are properly applied to very different plants. Unlike most annual weeds, the prickly lettuce is very troublesome in meadows and permanent pastures. Clover intended for a seed crop is often entirely ruined. Oats and other spring grain crops suffer more or less damage. When it is mixed with grain its milky juice is very troublesome in thrashing. Sheep and sometimes cattle will eat the young prickly lettuce, and in some localities their services have been found very effective in keeping it down, especially in recently cleared land where thorough cultivation is impossible. Repeatedly mowing the plants as they first begin to blossom will prevent seeding and eventually subdue them. Thorough cultivation with a hoed crop, by means of which the seed in the soil may be induced to germinate, will be found most effective. Under no circumstances should the mature seed-bearing plants be plowed under, as that would only fill the soil with seeds buried at different depths to be brought under conditions favorable for germination at intervals for several years. Mature plants should be mowed and burned. As the seed may be carried a long distance by the wind the plants must be cleared out of fence rows, waste land, and roadsides.

Bracted Plantain.—Although generally reported as new, this plant has doubtless existed before in small quantity and with less robust habit in many places. In some instances, however, it is known to have been introduced during recent years in lawn grass seed. Its seeds are known to seedsmen as western buckhorn or western ripple.

The bracted plantain is an annual, sometimes a winter annual, and in some cases the roots are apparently perennial. The leaves are not killed even by severe frosts. It is closely related to the lance-leaved plantain, or rib grass, and to the woolly plantain. The seed-bearing stems, 5 to 12 inches in height and numbering 5 to 25 on each plant, as in other plantains, are leafless and naked near the base. Each flower produces two seeds in an egg-shaped capsule which opens transversely, the dome-shaped lid with the persistent, papery corolla lobes falling away with the two seeds hanging in it. This kind of parachute enables the seeds to be carried a short distance by the wind. They usually fall near the parent plant, hence after the first introduction the bracted plantain grows in dense colonies, covering the ground so thickly as to choke out all other vegetation. An average plant produces about 15 flower spikes, and an average spike bears about 100 flowers or 200 seeds, making a

total of about 3,000 seeds to the plant. The bracted plantain is so low and inconspicuous and its leaves are so much like those of grass that it is not easily discernible until the flower spikes appear. Hand pulling and burning is perhaps one of the best remedies where the plants are not too abundant. If the land has become thoroughly seeded a series of hoed crops will probably be necessary to clear it out. In permanent pasture, mowing the plants as the seed stalks first appear will keep them in subjection. The mowing will have to be repeated several times, however, as the bracted plantain sends up seed stalks from May until November.

Horse Nettle.—Horse nettle is closely related to the common potato. The plants are 6 to 20 inches in height, loosely branching, rough, with short stiff hairs, and armed with yellow prickles. The plant is reproduced by the seeds, which are borne in the berries, and it is abundantly propagated, also, by slender, perennial running roots. It is more or less troublesome in nearly all crops and in all soils, but is worse in sandy or loose, friable soils, which are easily penetrated by the long roots. The production of seed may be prevented by keeping the plants mown. The roots must be killed, however, and this task is about as difficult as killing the root of the Canada thistle; in fact, the methods which are most successful in destroying the Canada thistle may be used with advantage in destroying the horse nettle.

Buffalo Bur.—This plant is also native in this country, originally growing on the western plains, close to the mountains, from Mexico northward. While the horse nettle has been slowly traveling westward the buffalo bur has been working eastward, until it is now found in many States east of the Mississippi River, and has even crossed the oceans, threatening to become a troublesome weed in Germany, Eugland, and Australia. Buffalo bur is related to the potato and closely resembles the horse nettle. It is an annual, easily subdued by preventing the production of seeds. This may be done by mowing as often as the yellow blossoms appear. The seeds are less abundant than those of most of the bad annual weeds, and they are often ripe, at least in the northern part of its range, until after the hurrying work of harvest is over. The buffalo bur is seldom troublesome in fields where thorough cultivation is practiced. The seeds may be expected as impurities in alfalfa and clover seed grown in the West. So far as known, however, in the East this weed has appeared first in waste places in cities and towns and has spread thence to the surrounding farms.

Spiny Amaranth.—The spiny amaranth, or prickly careless weed as it is often called, is native in tropical America, and seems to have been first introduced into this country along the southeastern coast. It is now more or less abundant in most of the States south of the Potomac and Ohio rivers, and is spreading with considerable rapidity. It resembles the common tumbleweed (*Amaranthus graecizans*) and other amaranths or careless weeds of the neglected cornfield and garden. This is an annual with a succulent stem, branching profusely throughout and attaining a height of

15 to 30 inches. The leaves are dark-green, lance-ovate, smooth, about 1½ inches long. At the base of the leaf stalk in most cases are two slender sharp spines, one-fourth to one-half inch long. The small, green flowers are crowded in slender spikes at the ends of the branches and in dense clusters in the axils of the leaves. The seeds, borne singly in the flowers, but aggregating several thousand on an average plant, are black and shining, round or slightly flattened, and about one twenty-fourth of an inche in diameter. Like other annuals it may be subdued by preventing the production of seed. It would readily succumb to thorough cultivation, as it grows rather slowly at first and does not produce seed until midsummer or later. Mowing or grubbing up the plant before the flower spikes develop is probably the best method of eradication in permanent pastures. Potato land and corn stubble may be plowed or thoroughly disked after the crop is harvested and a winter crop sown which will keep down the weeds.

Spiny Cocklebur.—This plant is often called dagger cocklebur. The stem branches from the base and grows to the height of 1 to 3 feet, bearing many narrowly ovate leaves about 1½ inches long, sometimes slightly toothed near the base, rather thick in texture, the upper surface dark-green with a whitish midrib, and the lower white with woolly pubescence. At the base of the leaf stem on one side is a three-pronged spine about an inch long. On the other side is an inconspicuous flower, followed by an oblong, spiny bur like those of the common native cockleburs, but smaller, about one-half inch long. Each bur contains two seeds. As they remain inclosed in the hard, spiny bur, they are seldom found in commercial seeds. Although this weed is an annual it is most troublesome in pastures and meadows, spreading even in strong sod. The growth of the spiny cocklebur at first is slow and, as it needs light and room to develop into a robust plant, it may be choked down by any quick-growing crop that will crowd and shade it. In permanent pastures and waste places, where it flourishes best, it could doubtless be eradicated in time by mowing the plants about twice each year, in August and September, or by cutting them up with a hoe or spud in May and June. As the seeds often lie dormant in the thick-walled bur several years before germinating, it might require a like period to exterminate a patch by this method; but the plants would continually be growing less in number, and the labor correspondingly lighter.

Chondrilla.—This plant has a rosette of root leaves similar to those of the dandelion, but the rigid, branching stems are bare, except for the inconspicuous linear bracts and the small yellow flowers. The lower part of the main stem is clothed with small prickles. The plant begins to bloom in June or July and continues to flower and produce seeds until killed by frost. The pappus enables the achenes (containing seed) to be carried a considerable distance by the wind. As the plant is usually most abundant in neglected pasture land where the soil is somewhat impoverished, it seems probable that cultivation and a supply of fertilizer would soon subdue

it. Left unchecked it not only occupies all the space where the grass has become thin, but encroaches aggressively on strong grass sod.

Wild Carrot.—The wild carrot is by no means a new weed, but it is spreading to new localities. It is one of the most aggressive weeds of Canada and the Eastern States, and is rapidly spreading westward, having been found at several points west of the Mississippi River. It seems to thrive well in nearly all kinds of soils, and in all climates from Maine to Georgia. The wild carrot is probably one of the worst weeds in America. The seed fruits are readily attached to passing animals and are distributed in that way, or they often remain undisturbed on the plant until winter and are then blown across the snow. Too often they are found in poorly cleaned clover and grass seed. The seeds, inclosed in their hard, spiny coat, retain their vitality for several years, and when once abundant in the soil they are likely to cause trouble during several seasons, even though fresh seeding is prevented. In permanent pasture the persistent mowing of the plants as often as the flower appears will eventually destroy them. They will continue to branch out from the base after each cutting until finally exhausted, so that the first mowing will often appear to increase rather than diminish their numbers. The root may be cut off with a spud some distance below the surface of the ground, a process that usually kills them at once. Pulling the plants by hand when the ground is wet, although somewhat laborious, is one the the surest methods of eradication. Sheep eating the young plants will aid considerably in keeping them down. The wild carrot is seldom troublesome in cultivated fields, which indicates that even moderate cultivation will partly subdue it, and that thorough cultivation of the fields, accompanied by the destruction of the weeds in waste places, would reduce it to comparative harmlessness.

Wild Oat.—Whether the wild oat and the wild carrot are retrograde developments from the cultivated oat and carrot are questions still unsettled, but doubtless both were introduced into this country as weeds, and they have certainly been propagated here as such. If the wild oat or the wild carrot has appeared in the cultivated field, it is because the seed of the wild oat or the wild carrot has been sown. The seeds of both are nearly like those of the cultivated plants, and in case of the oat the seed of the wild plant may easily be sown mixed with good oats. Three species of wild oats have been introduced into this country, all quite similar in appearance and all annual weeds. The most common species, *Avena fatua,* is readily distinguished from the cultivated oat by its usually larger size and earlier and irregular ripening, by the separate florets falling as soon as ripe, and by the long, stout, twisted and bent awns borne by the first and second florets. The grain retains its vitality much longer than does the common oat, and may remain buried in the soil several years without germinating. It germinates best when there is an abundance of moisture and the soil is warm. To clear the seed out of the soil, therefore, the land should be stirred when it is warm and as moist as will permit good cultivation. The

clearing of the soil can be accomplished in conjunction with the cultivation of corn or root crops. Where winter wheat and rye may be grown profitably the land should be plowed as soon as possible after the spring crop is harvested, and harrowed about once a week until time for sowing the wheat or rye. Oats should be left out of the rotation so far as may be until the wild oats are subdued, as the latter growing among the cultivated oats are difficult to detect for removal, and after harvesting and thrashing it is practically impossible to separate completely the two kinds of grain.

False Flax.—This plant is a member of the mustard family. It resembles flax somewhat, but has much smaller flowers and seeds, and its seed capsules are pear-shaped instead of spherical. It is an annual, like shepherd's purse, pepper-grass, and most of the other troublesome weeds of the mustard family. The seeds germinating in the fall produce a rosette of leaves in the same manner as the dandelion. In the spring a seed stalk is developed from the midst, and after the seeds are matured the plant dies. The seeds germinating in the spring produce plants that usually blossom during the same season, but seldom mature seeds, being killed too early by the frost. The seed occurs as an impurity in flaxseed and clover seed, and in some of the grass seeds, especially timothy. Where the false flax has become abundant it may be necessary to omit winter wheat and rye from the rotation for a few years and raise crops that will permit cultivation in autumn. Spring grain crops may be grown, or hoed crops may occupy the ground during the summer. Hoed crops may be employed to best advantage, as the cultivation given to these crops will induce the false-flax seed to germinate and thus clear the land sooner. In pastures and meadows the weeds may be pulled if they have not become too abundant; but if this work has been long neglected it will probably be necessary to plow and cultivate the land.—(F .B. No. 28.)

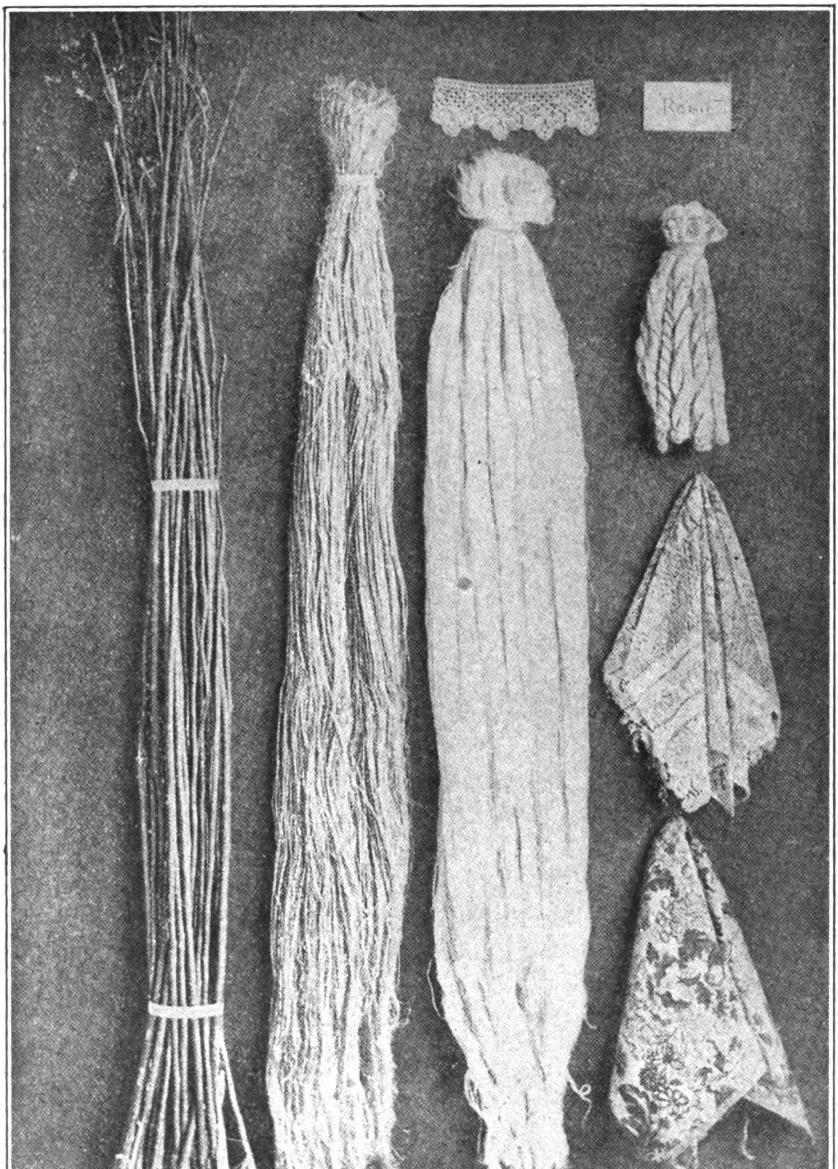
A FEW MORE OF THE WORST WEEDS.

Canada Thistle, Field Thistle (*Carduus arvensis*).—This field pest is well enough known by name, yet a good many persons are mistaking it for other plants and calling other plants the thistle. The essential differences from other thistles are the underground stems (with numerous shoots coming to the surface) the lobed and very spiny leaves and the smaller heads. The absence of the thick tap-root alone usually makes us certain that we have to do with the so-called Canada thistle. It is incorrectly so-named, because it is introduced from Europe and not from Canada. The specific name "*arvensis*" means growing in fields, hence field thistle is a much more correct name. Perhaps there is no weed name that carries with its utterance more of dread to the land-owner than that of Canada thistle, yet its most noxious feature, that of creeping, rooting, underground stems, is possessed by a dozen or more others, including horse-nettle, toad-flax, milkweed, ground-ivy, cypress-spurge, nut-grass, periwinkle, bracted bindweed, field bindweed, quack-grass, dogbane and elders. While this is a vile weed it has been over advertised in comparison with some others equally as bad. It

has been asserted that the Canada thistle does not mature seeds in some sections. Though it may not ripen seeds south of a given latitude, it certainly appears to form viable seeds in unexpected quarters. It springs from seed in many new places each year, and spreads from the underground growth in the others. Seeds gray, oblong, ⅛ inch long, striate with obscure lines and with a copious pappus by which they may be carried many miles; present in hay and seeds. In the latter, if known, their presence is a punishable offense. The underground stems must be starved out to kill Canada thistle. Destruction of this weed falls under two plans: For the first, repeated cutting with hoe and applications of salt, kerosene (coal oil) or sulphuric acid to the cut stems in the ground will usually prove the cheapest and best method. The treatment, at least the cutting, needs to be repeated as often as green leaves of the thistle show above ground. Cutting alone will be sufficient to destroy them but it will need to be followed for two or more seasons to be effectual. In areas too large to be destroyed by hand work, the summer fallow may be used, to be followed by hand treatment to kill out the small remaining areas. The field should be plowed shallow in June and harrowed to destroy all green tops. Upon the appearance of new growth of the thistles it should be cross-plowed and again harrowed. This procedure is repeated throughout the season to be followed by carefull tillage the next year in corn, potatoes or some other crop that is to receive all-summer hoeing and cleaning. After this some patches will commonly remain to be killed out as first suggested. Refuse packing or house salt, is perhaps the cheapest chemical to apply after cutting. Kerosene is sometimes recommended, yet costs more, while sulphuric acid is dangerous to handle, although effective in burning up and destroying whatever it may be applied to. Smothering with straw is rarely successful, since the thistles finally grow through it, aside from its depriving the owner of the use of the land for a longer time than summer fallow. The correct principle of destruction is, however, of more importance than the mere method. This is to starve out the underground stems. Two or more seasons will be needed.

Common Thistle, Bull Thistle (*Carduus lanceolatus*).—The common, purple-flowered thistle found in pastures is a biennial, 2 to 4 feet high, with deep tap-root. The plants start in the fall and may be seen during winter waiting for the next summer to blossom and fruit. Seeds gray, larger than those of the Canada thistle, ¼ inch long and abundantly supplied with pappus. Common in hay and seeds. Destroyed by cutting off below crown before blossoming, usually not destroyed by mowing.

Black Mustard (*Brassica nigra*).—Black mustard is a tall, prickly plant, growing in waste places and fields. It is often confused with the next, from which it is distinguished chiefly by the pods. Seeds black to dark brown, commonly spherical or ellipsoidal, 1-20 inch long, slightly granular-roughened. Frequent in seeds of clover and grasses, also in forage, but apparently less common than the next; dealt with in the same manner as charlock.



RAMIE—DRIED STALKS, RAW FIBER, DEGUMMED FIBER, AND MANUFACTURES. YEAR BOOK, 1894.

English Charlock, or Wild Mustard (*Brassica arvensis et Sinapistrum*).—This is the commonest and worst pest among the Brassicas; it is the plant mostly called wild mustard. It is distinguished from the others by its long knotted pod, with its stout, two-edged beak. It is among the very worst weeds known to farmers, especially in the northern and mid-Western states, where oat growing is largely practiced. It comes up and grows with the oats, remaining in them when threshed, or having seeds already ripened when mown for hay. With other Brassicas, charlock harbors the club-root fungus, *Plasmodiophora Brassicæ.*

Seeds spherical, 1-16 inch in diameter, larger than those of black mustard. Very common in hay, in seed oats, and in clover seed; retaining their vitality for a long time when buried in the soil. The measures here recommended will apply to black and spreading mustard as well. The oat crop seems to be one particularly favorable to the propagation of these two mustards. Infested land may be rendered comparatively free from them by surface burning and continuous cultivation in hoed crops or by spraying. Where a limited quantity is to be dealt with, hand pulling from the grain, is to be recommended.

Spraying to destroy charlock and other mustards is a recent practice which originated in France and became known in America in 1898. Experiments in the United States and Canada have fully confirmed the European results as to safe destruction of these weeds by the spray. The method is to use a solution of either copper sulphate (blue vitriol) or iron sulphate (copperas) as a spray; of the copper sulphate 2, 2½ or 3 per cent solution (8, 10 or 12 lbs. in 50 gallons), applying 40 to 50 gallons to the acre upon the fields of grain containing mustard plants in dry weather either cloudy or bright and sunny. The most effective results are obtained before the mustard comes into bloom. While the cereals, such as corn, oats and wheat, may show slight apparent injury at the time, the injured plants appear to recover and the mustard is killed or prevented from seeding. Showers soon after spraying may require repetition of spray. This will kill or injure practically all plants of the mustard family if applied on the foliage; to be especially recommended in wheat and oats on this weed. Of the iron sulphate solution, 15 to 20 per cent solution (60 to 80 lbs. in 50 gallons) may be employed as the chemical is cheaper though less active.

Broad Plantain (*Plantago major*).—The broad plantains are annoying weeds, more particularly in manured land. They have thick rootstock like the last, broad, oval, ribbed, green leaves and the latter one named, very long tapering spikes of flowers and seeds. In enriched fields seeded to clover and the like, the broad plantains are frequently serious pests; they are ever present about yards and waste places. The recognition of the plants is not a difficult matter, but the recognition of the seed is all essential since it is so frequently an impurity in clover seed. Seeds dark brown to black, very irregular in shape, with rounded back and variously flattened; sloped or angled on the other side, 1-12 inch long or less, by about one-

half as wide. Very common in clover seed. The broad plantains may be removed by hand from yards and lawns. In clover fields continuous cultivation is required. This will be the same as that recommended for mustards in clover.—(Ohio A. E. Sta. B. 175.)

Orange Hawkweed or Paint Brush.—This is perhaps one of the worst weeds in the East. Paint brush has come to stay. It is not native of this country. It has been reported by farmers in many counties in N. Y. State.

This weed was first noticed there about 35 years ago. It doubtless escaped from cultivation, as it has often been used for ornamental purposes. Its spread has been exceedingly rapid, and in sections where it was but little known only a few years ago it now covers large fields. Orange hawkweed or paint brush is a perennial plant, that is, it belongs to that class of plants which live for more than two years. It has a very shallow root system. It has two methods of reproduction—by seeds and by runners. The runners are very similar to those of the strawberry plant, and in a very short time this weed will spread over large areas by means of the runners alone. The seeds, which are borne in great numbers, resemble the seeds of the thistle and the dandelion, and are blown about by the wind in the same manner. Although there is no probability of ever getting entirely rid of the weed there are some methods of control which are more or less successful.

Three thousand pounds of salt per acre is required to kill the paint brush. The salt is said to destroy the weed without damaging the grass. This method may be advisable for very small areas but it will never be practicable for large areas, as it is too costly. Under some conditions the salt would cost as much as the land is worth. Moreover, the weed would spring up again in the same place in a few years and the operation would have to be repeated. In small areas the plants may be killed by hoeing. If this is done just as the plants are blossoming or before they begin to blossom, they will not reappear in that place again for some time. The seeds should not be allowed to ripen.—(Cornell A. E. Sta. B. 9.)

The Perennial Sow Thistle (*Sonchus arvensis*).—This weed now stands in the same class as the Canada thistle, and in many parts of the country it is considered the worst noxious weed with which the farmer has to contend. It has gained a foothold in most places before the people recognized the plant, but once the plant is identified it will not likely be overlooked. Unlike wild oats, there is no difficulty in knowing sow thistle as soon as it appears above the ground. Like the Canada thistle, the perennial sow thistle has a long, underground, creeping stem, which will produce a new plant every few inches. By spreading in this way it is able to take complete possession of the ground, crowding out the young grain plants before they get a start. This weed, in some respects, is more difficult to eradicate than the Canada thistle. The root stocks spread and the winged seeds scatter just as freely as in the case of the Canada thistle, and, besides, the seed of this weed is more viable, as nearly every seed will grow.—(Man. Bul. 2.)

European Bindweed or Morning Glory.—The European bindweed or morning glory is a deep rooting perennial with twining or creeping stems. The small arrow shaped leaves are an inch or two long. The flowers are an inch or less long, short or broadly funnel shaped, white, blueish, or commonly of rose tinge. The American wild morning glory or hedge bindweed differs from the preceding in that the leaves are larger, triangular, halberd or arrow shaped. The flowers are white tinged with rose purple and much larger than the European morning glory. The morning glory must be treated as the horse nettle as it is a perennial. In addition to the usual methods of cultivation, sheep have been recommended to destroy the weed. This method is certainly applicable where the weed occurs in pastures.—(Iowa B. 70.)

Burdock (*Arctium Lappa*).—It is a coarse, branched biennial from a foot to three feet high; hairy; leaves large, roundish or heart shaped, thin, obtuse, entire or dentate, floccose tomentose beneath. The plant is enormously productive. It begins to bear fruit the second year and continues to flower till frost. In fact, it is capable of standing considerable frost. The achenes (seeds) are small, oblong, flattened affairs, having a short pappus ("hairs") which soon falls off. There are several well-marked varieties which differ mainly in size of the leaves and heads. Burdock is easily destroyed. Since it is a biennial cut off below the crown during the summer. If it comes up again, cut off once more, or as often as may be necessary. The important thing is not to allow it to go to seed; it will then die if left to itself.—(Iowa Agr. Exp. Sta. B. 70.)

Curled or Yellow Dock.—There are several species of dock common in meadows. Several of them are quite troublesome as weeds at times. Among the docks may be mentioned the curled dock *Rumex crispus.* This is a smooth perennial from three to four feet high, leaves with strongly wavy and curled margins, lanceolate and acute. In the lower leaves the bases somewhat truncate or inclined to be heart-shaped. The flowers are collected in dense whorls, extended or prolonged into racemes, entirely leafless above, but below with small leaves. The flower consists of six sepals, the outer herbaceous, leaflike, the three inner larger and somewhat curled, and after flowering forming the valves of the fruit. These surround the three angled fruit (achene), all the valves bearing a grain. The *R. altissimus,* occurs in low ground. The leaves are longer, oblong, lanceolate, acute, pale, thickish, but not with wavy curled margins as in *R. crispus.* The racemes are long, spike-like panicled, nearly leafless. Both of the species mentioned here are perennial. One of the most efficient means of destroying this weed is to root it out by the hand and this is done very readily in the spring when the soil is wet by taking hold of the plant just at the surface of the ground, giving the root a slight twist and at the same time an upward pull, and the root will readily come from the soil. Where it is common, however, it is sometimes plowed or a spud is used. This method is not, however, so effective as the pulling method.—(Iowa Bul. 70.)

Dodder (*Cuscuta*).—The term "dodder" is the common name applied to the several species of a genus of parasitic plants represented in all parts of the world. The species of dodder infesting various plants, but especially alfalfa, are mostly natives of this country, though a few have been introduced from Europe. They are flowering annual plants, having slender, leafless stems about the size of small wrapping twine. The general color of the dodder stem is from that of straw to orange, or reddish yellow. The green color common to most herbs is never seen in the stem of the dodder, owing to the fact that the plant produces no chlorophyll, to which is due in most plants not only their green color, but also their power to transform the crude materials taken from the soil into vegetable tissues. The dodder has no such power; hence the peculiarity of the life-history of these plants.—(Nev. Bul. 15.)

Thus the dodder is unable to provide for itself, and so is dependent upon some other plant for its maintenance. During the first stages of germination the young plantlet is self-supporting, wholly dependent, however, upon the store of nourishment contained within its seed. This consists of starch. When this nourishment is exhausted the young plantlet has attained a height sufficient to permit it to grasp and twine its stem about some plant that may be sufficiently near. This occurs providing the plant be one for which the dodder has a natural affinity. When these conditions obtain, minute haustoria (suckers) are thrown out by the parasitic dodder at points where its stem comes in close contact with that of the plant to which it clings. One species of dodder, *Cuscuta epithymum,* Murr., is found extensively in alfalfa fields. Stems slender, twining, leafless, light but never green in color, bearing suckers at points of contact with the host plant, dying away at base soon after germination and continuing to live from plant adhered to; flowers small, less than one-eight inch long, general color white, usually densely clustered, blooming late in the season; seeds minute, almost spherical, rough, one to four from each flower; embryo slender, coiled spirally, destitute of cotyledons.

As the dodder is apt to spread rapidly when once established in a field, some effective remedy alone can prevent this, and at the same time eradicate the pest. Probably the most effective remedy, and one easily suggested, is that of burning the infested area. If this is done in late Autumn the best results will doubtless follow, as at this time the seeds of the dodder have but recently reached maturity and are either still in the seed capsules or simply resting on the surface of the ground. In either case a quick, hot fire, burning closely to the ground, will suffice; and, if such, will probably do no injury to future crops of alfalfa from the same roots. The standing alfalfa mowed and allowed to dry for a day of two probably would furnish sufficient heat, and this, too, at the right place. Sulphate of iron (green vitriol) if sprinkled upon the dodder is said to kill it without injury to the alfalfa.—(Grasses of North America.)

Better than any remedy, however, is a means of prevention.

This should result from an examination of seeds used if the appearance of the dodder seed is known.—(Nev. Bul. 15.)

The Wild Onion or Wild Garlic (*Allium Vineale L.*).—This is one of the worst weeds to eradicate after it has once gained a foothold, being propagated by underground bulbs, aerial bulblets, and in some sections by seeds.—(U. S. Dept. Agr. B. P. I. Bul. 100.)

The Wild Onion, also known as Field Garlic, Crow Garlic and Crow Allium, is considered by many the vilest weed pest common to the sections where it grows. It is a frequent occurrence for the Experiment Station to receive letters from farmers relative to this pernicious weed. Complaints are made as to the trouble which it gives in dairying, and information is eagerly sought as to how it may be successfully combated.—(Tenn. Bul. 2, Vol VIII.)

This is the only plant with onion-like scent common in fields. It produces an abundance of bulbs or sets deep in the soil and a cluster of bulblets in place of seed. There are two types of underground sets, one with a hard coating and capable of living for a long time in the soil and softer ones which usually produce the next year's growth. These methods of propagation spread it freely and permanently and the disagreeable flavor it imparts to milk from cows grazing in fields where it grows and to flour from wheat containing the bulblets, make it a most formidable pest to dairymen and grain growers. It is probably scattered chiefly by the bulblets in seed grain but seeds are sometimes produced. It can be removed from wheat by fanning, preferably after drying. It can be kept down in fields by deep fall plowing to prevent winter growth of leaves, followed by a smothering crop. In a field on the Experiment Station farm plowed last December, garlic is entirely absent while it is very abundant on adjacent parts of the field plowed in the fall.—(Maryland Agr. Exp. Sta. Bul. 155.)

In the following tabulated pages are mentioned one hundred varieties of weeds:

TABLE OF ONE HUNDRED WEEDS.

NOTE 1.—This table presents the common and technical name, with some of the characteristics, of one hundred **weeds which are regarded as the most** troublesome in the United States.

NOTE 2.—By alternate cultivation and smothering crops is meant clean cultivation during the dry season and a heavy **seeding of some annual crop, as crimson** clover, cowpeas, millet, or oats, that will cover the ground thickly and choke down the weeds during the growing season.

NOTE 3.—**Under color and** size of flowers the **most prominent color and the approximate diameter of a single flower, or of a head in the case of composites are given.**

Common names.	Technical name.	Where injurious	Duration.	Time of flowering.	Time of seeding	Color, size, and arrangement of flowers.	Methods of propagation and distribution of seed.	Place of growth and products injured.	Methods of eradication.
Barnyard grass, barn grass, cocksfoot.	Panicum crus-galli	Minnesota to Montana	Annual.....	June to August.	July to September.	Green; ⅛ in.; panicle.	Seeds; in grain seed.	Fields; spring wheat.	Prevention of seeding.
Black mustard.........	Brassica nigra....	Washington to Cal.	.....do.....	June to September	July to October.	Yellow; ¼ in.; panicle.	Seeds; in grass and grain seed.	Fields; grain crops.	Prevention of seeding; hoed crops.
Bracted plantain, rib grass, buckhorn, western buckhorn.	Plantago aristata..	Ohio to Iowa	.....do. (?).	May to October.	June to December.	Green; ¼ in.; spike.	Seeds; in grass and clover seed.	Meadows; pastures.	Do.
Brake, eagle fern......	Pteridium aquilinum	Washington to Cal.	Perennial..	....	....	Flowerless.....	Rootstocks; spores.	.......do.......	Heavy seeding; cultivation.
Broom rape...........	Orobanche ramosa	Kentucky to North Carolina.	Annual.....	June to August.	July to September.	White; ½ in.; spike.	Seeds...........	Hemp; tobacco; tomatoes,	Clean seed; cultivation of crops other than hemp, etc.
Buffalo bur, beaked horse nettle.	Solanum rostratum.	Iowa to Colorado.	.....do.....	June to September.	July to November.	Yellow; ½ in.;	Seeds; tumbleweed.	Grain; hoed crops.	Heavy seeding; close cultivation.
Bull thistle, common thistle.	Carduus lanceolatus.	Everywhere	Biennial...	June to August.	.....do.....	Purple; 1 in.; head.	Seeds; wind....	Meadows; winter wheat.	Prevention of seeding; cutting in fall.
Burdock, great dock..	Arctium lappa....	New England to Wisconsin	.....do.....	July to September.	August to October.	Purple; ½ in.; head.	Seeds; animals.	Waste places; pastures; wool.	Prevention of seeding; grubbing in summer.
Bur grass, hedgehog grass, Rocky Mountain sand bur, sand bur, sand spur.	Cenchrus tribuloides.	Everywhere	Annual.....	June to October.	July to November.	Green; bur....	.... do........	Sandy pastures; wool.	Cultivation; burning.
Button weed, alligator head.	Diodia teres......	Maryland to Louisiana.	.....do.....	.....do.....	.....do.....	Green; 1 line; axillary.	Seeds...........	Waste places; hoed crops; grainfields.	Prevention of seeding; close cultivation.
Canada thistle.........	Carduus arvensis..	New England to Iowa	Perennial..	June to September.	July to October.	Purple; ¾ in.; head.	Creeping roots; seeds.	Fields; grain; meadows.	Alternate cultivation and heavy cropping.
Charlock, wild mustard, yellow mustard.	Brassica arvensis.	New England to N. Dakota.	Annual.....	May to September.	June to October.	Yellow; ¼ in.; panicle.	Seeds; in grain seed.	Fields; grain.	Prevention of seeding; cultivation; hoed crops.
Chess, cheat, wheat thief, Willard's brome grass.	Bromus secalinus	New England to Washington	.....do.....	July to September.	August to October.	Green; panicle	........do........	.......do.......	Clean seed; cultivation.
Chickweed.............	Alsine media......	New York to N. Carolina	.....do.....	February to June.	March to July.	White; ¼ in.; clusters.	Seeds; in grass seed.	Lawns, gardens; spring crops.	Cultivation in late fall and early spring.

Chondrilla, gum succory, skeleton weed, stick-weed.	Chondrilla juncea.	W. Virginia to Maryland	Biennial	June to November.	July to December.	Yellow; ½ in.; solitary.	Seeds; wind	Waste places; pastures.	Cultivation; hoed crops.
Clover dodder, alfalfa dodder, love vine.	Cuscuta epithymum.	Utah to Nebraska; New England.	Annual	....do....	June to November.	Yellow; ⅛ in.; clusters.	Seeds; in clover and alfalfa seed.	Clover; alfalfa.	Clean seed; cultivation.
Cockle, corn cockle, rose campion.	Agrostemma githago.	New England to Wash.	....do....	June to August.	July to September.	Purple; 1 inch solitary.	Seeds; in grain seed.	Grainfields; wheat.	Do.
Cocklebur, clot bur, ditch bur, small burdock.	Xanthium canadense, Xanthium strumarium.	Everywhere	....do....	July to October.	August to November.	Green; ⅜ in.; heads.	Seeds; animals	Waste places; pastures; wool.	Prevention of seeding; cultivation.
Couch grass, quack grass, quick grass, witch grass, devil's grass, durfee grass.	Agropyron repens.	New England to Minn.	Perennial.	July to August.	August to September.	Green; spikes.	Rootstocks	Fields; all crops except hay.	Alternate cultivation and heavy cropping; close grazing.
Cow herb, cockle, cow basil, cow fat, glond.	Vaccaria vaccaria.	Colorado to Utah.	Annual	June to July.	July to August.	Pink; ¾ inch; cymes.	Seeds; in grain seed.	Fields; grain	Prevention of seeding; clean seed.
Crab grass, finger grass, Polish millet.	Panicum sanguinale.	New Jersey to Missouri and south.	....do....	June to September.	July to October.	Green; spikes.	Seeds; runners	Hoed crops	Prevention of seeding; closer cultivation.
Curled dock, yellow dock.	Rumex crispus	New England to Washington.	Perennial.	....do....	....do....	Green; ¼ in.; panicle.	Seeds; crown-forming root.	Meadows; grain crops.	Alternate cultivation and heavy cropping.
Dandelion	Taraxacum taraxacum.	Nearly everywhere.	....do....	May to October.	May to November.	Yellow; 1 in.; head.	Seeds; wind; crown-forming root.	Meadows; lawns.	Cultivation; digging roots in lawns.
Devil's weed, devil's paint brush, king devil weed, golden hawkweed.	Hieracium praealtum.	New York	....do....	July to September	August to October.	....do....	Seeds; wind; rootstocks; runners.	Meadows; pastures.	Sheep pasturing; cultivation and heavy cropping.
Dog fennel, Mayweed.	Anthemis cotula.	Everywhere	Annual	June to August.	July to September.	White; ¾ inch; head.	Seeds	Roadsides	Prevention of seeding.
English bindweed, morning-glory.	Convolvulus arvensis.	New England and Cal.	Perennial.	June to September.	August to October.	White; 1 inch; solitary.	Seeds; creeping roots.	Grainfields; hoed crops.	Prevention of seeding; late cultivation.
False flax, gold of pleasure, wild flax.	Camelina sativa	Michigan to Minnesota.	Annual	May to July	June to August.	Yellow; ⅛ in.; raceme.	Seeds; in flax and grain seed.	Flax and winter grain.	Prevention of seeding.
Field dodder, love vine, clover dodder.	Cuscuta arvensis	New England to Ohio and southward.	....do....	June to November.	July to November.	Yellow; ⅛ in.; clusters.	Seeds; in clover and alfalfa seed.	Clover; alfalfa	Clean seed; cultivation of crops other than clover.
Fleabane, daisy fleabane, sweet scabious, white-top.	Erigeron annuus	Maine to Minnesota and south.	....do....	June to August.	July to September.	White; ⅜ in.; heads.	Seeds	Waste places; meadows.	Prevention of seeding.
Franseria	Gaertneria discolor.	Wyoming to New Mexico	Perennial.	....do....	....do....	Yellow; ¼ in.; heads.	Rootstocks	....do....	Thorough cultivation.
Great ragweed, hogweed.	Ambrosia trifida	Iowa to Louisiana & east	Annual	July to September.	August to October.	....do....	Seeds	Bottom lands.	Cultivation; heavy cropping.
Gum Plant, rosinweed, sunflower.	Grindelia squarrosa.	North Dakota to Utah.	Perennial.	....do....	August to November.	Yellow; ½ in.; heads.	Seeds; animals; crown-forming root.	Meadows; pastures.	Prevention of seeding; cultivation.
Hedge bindweed, morning-glory.	Convolvulus sepium.	New Jersey to Illinois.	....do....	....do....	August to October.	White; 2 inches solitary.	Seeds; rootstocks.	Corn and grainfields.	Late cultivation.

Table of one hundred weeds.—Continued.

Common names.	Technical name.	Where injurious.	Duration.	Time of flowering.	Time of seeding.	Color, size, and arrangement of flowers.	Methods of propagation and distribution of seed.	Place of growth and products injured.	Methods of eradication.
Horse nettle, bull nettle, sand briar.	Solanum carolinense.	Iowa to New Jersey and south.	Perennial..	June to October.	August to November.	Purple; 1 in.; solitary.	Seeds; running roots.	Waste land; meadows; pastures.	Alternate cultivation and heavy cropping.
Horseweed, butterweed, colt's tail, fleabane.	Leptilon canadense.	Everywhere	Annual.....	June to September.	July to October.	White; ¼ in.; head.	Seeds; wind.....	Waste land; meadows; grainfields.	Prevention of seeding; late cultivation.
Indian mallow, butter print, stampweed, velvet leaf.	Abutilon abutilon..	Illinois to Iowa and Missouri.	.....do.....	July to August.	August to September.	Yellow; ½ in.; solitary.	Seeds...........	Cultivated lands.	Prevention of seeding.
Jimson weed, Jamestown weed, thorn-apple.	Datura tatula......	Virginia to Texas.	.....do.....	July to September.	August to October.	Purple; 3 inches; solitary.	....do...........	Waste places..	Do.
Johnson grass, Cuba grass, Australian millet, Egyptain millet, evergreen millet, Means's grass	Andropogon halepensis.	North Carolina to Tex. and California.	Perennial..	June to August.	July to September.	Green; ⅛ in.; panicle.	Rootstocks; seeds.	Cultivated fields; hoed crops.	Alternate cultivation and heavy cropping.
Lamb's quarters, pigweed.	Chenopodium album.	Everywhere	Annual.....	July to September.	August to November.	Green; $\frac{1}{16}$ in.; panicle.	Seeds...........	Waste places..	Prevention of seeding.
Live forever, garden orpine.	Sedum telephium..	New York to Pennsylvania	Perennial..	July to August.	August to September.	Purple; ⅛ in.; cyme.	Rootstocks; seeds.	Fields.........	Infection with fungous disease; close cultivation.
Malva.................	Malva parviflora...	California, Arizona.	.....do.....	June to August.	July to September.	Purple; ⅛ in.; solitary.	Seeds; rootstocks.	....do.........	Prevention of seeding; thorough cultivation.
Manroot, man-of-the-earth, morning-glory.	Ipomoea pandurata.	Delaware to Missouri.	.....do.....	July to September.	August to October.	White; 3 inches; solitary.	....do...........	....do.........	Prevention of seeding; killing roots with coal oil.
Marsh elder, highwater shrub, false sunflower.	Iva xanthifolia.....	Minnesota to Utah.	Annual.....	August to September.	September to October.	Green; ¼ in.; heads.	Seeds...........	Fields; pastures; grain crops.	Prevention of seeding.
Mexican tea, pigweed..	Chenopodium ambrosioides.	Virginia to Louisiana.	.....do.....	.....do.....	August to October.	Green; $\frac{1}{16}$ in.; spikes.	....do...........	Waste places..	Do.
Milkweed, cottonweed, silkweed.	Asclepias syriaca..	New York to Nebraska.	Perennial..	July to August.	August to September.	Purple; ½ in.; umbel.	Seeds; wind; creeping roots.	Fields.........	Prevention of seeding; cultivation; heavy cropping.
Morning-glory.........	Ipomoea nil, Ipomoea purpurea...	Delaware and California.	Annual.....	July to November.	August to December	Purple; 2 inches; solitary.	Seeds...........	Cultivated fields.	Prevention of seeding; thorough cultivation.
Moth mullein.........	Verbascum blattaria.	Maryland to Ohio and Oregon.	Biennial...	June to October.	July to November.	Yellow; ¾ in.; raceme.	Seeds; in grass seed.	Meadows......	Sowing clean seed; cultivation; grubbing in fall.

Musky alfilerilla, ground needle, musky heronbill.	Erodium moschatum.	California to Arizona.	Annual	April to July.	May to August.	Rose; ¾ inch; umbel.	Seeds	Pastures	Sowing clean seed; burning.
Narrow-leaved stickseed, beggar tick.	Lappula lappula	Everywhere.	do	July to September.	July to October.	Blue; ⅛ inch; raceme.	Seeds; animals	Everywhere; wool; crops.	Sowing clean seed; cultivation.
Nut sedge, nut grass, coco, coco sedge.	Cyperus rotundus	Maryland to Arkansas and Texas.	Perennial	July to October.	August to November.	Brown; 1/16 in.; spikelets.	Tubers; in nursery packing; seeds.	In hoed crops	Alternate cultivation and smothering crops.
Orange hawkweed, ladies' paint brush, red daisy.	Hieracium aurantiacum.	New York	do	July to September.	August to October.	Orange; ½ in.; solitary.	Seeds; wind; runners; rootstocks.	Meadows; pastures.	Prevention of seeding; cultivation; salt.
Ox-eye daisy, bull's-eye, white daisy, whiteweed.	Chrysanthemum leucanthemum.	Maine to Virginia and Ohio.	do	June to September.	July to October.	White; 1 inch; solitary.	Seeds; rootstocks.	do	Do.
Paraguay bur, sheep bur.	Acanthospermum xanthioides.	North Carolina to Fla.	Annual	May to November.	June to December.	Yellow; ¼ in.; heads.	Seeds; animals; runners.	Waste places; pastures; wool.	Cultivation.
Paroquet bur	Triumfetta semitriloba.	Hawaii; Porto Rico; Florida.	do	June to November.	July to December.	Yellow; ½ in.; panicles.	Seeds; animals.	Waste places; cultivated land, wool.	Do.
Passion flower, maypop.	Passiflora incarnata.	North Carolina to Florida.	Perennial	July to September.	August to October.	White; 2 inches solitary.	Seeds	Hoed crops	More thorough cultivation; prevention of seeding.
Pennycress, Frenchweed.	Thlaspi arvense	North Dakota to Minn.	Annual	May to November.	June to December.	White; ⅛ inch. raceme.	Seeds; wind	Grainfields pastures; dairy products.	Burning, thorough cultivation.
Pigeon grass, foxtail, yellow foxtail.	Setaria glauca	Everywhere	do	June to September.	July to November.	Green; 1/16 in.; spikes.	Seeds; in clover seed.	Cultivated land; grain crops.	Do.
Pigweed, careless weed, rough amaranth.	Amarantus retroflexus.	do	do	July to October.	August to November.	Green 1/16 in.; spikes	Seeds	Cultivated land; all crops.	Prevention of seeding; thorough cultivation.
Poison ivy, poison oak, poison vine.	Rhus radicans	do	Perennial	June to July.	July to August.	Yellow; ¼ in. raceme.	Rootstocks; seeds.	Waste land poisonous to man.	Cultivation; repeated grubbing.
Poverty weed	Iva axillaris	Montana to New Mexico.	do	June to August	July to September.	Yellow; ¼ in.; heads.	do	Cultivated land; all crops.	Closer cultivation, smothering crops.
Prickly lettuce, compass plant, milkweed, wild lettuce.	Lactuca scariola integrata.	Ohio to Iowa and Utah to Oregon.	Annual	June to October	July to November.	do	Seeds wind	Everywhere all crops.	Prevention of seeding. burning.
Prickly pear, cactus, Western Prickly pear.	Opuntia humifusa	Oklahoma, Texas, New Mexico.	Perennial	do	July to December.	Yellow; 2 to 3 inches; solitary.	Seeds; animals	Pastures	Permitting grass to grow and burning.
Purslane, garden purslane, pursely, pusley.	Portulaca oleracea	Everywhere	Annual	May to November.	June to December.	Yellow; ¼ in.; solitary.	Seeds	Cultivated land; garden crops.	Closer cultivation.
Ragweed, bitterweed, hogweed, richweed, Roman wormwood.	Ambrosia artemisiaefolia.	do	do	July to October.	August to November.	do	Seeds; wind	Everywhere; all crops.	Prevention of seeding; burning.
Rattlebox	Crotalaria sagittalis.	Iowa to S Dakota.	do	July to September.	do	do	Seeds	Pastures; poisonous to stock.	Cultivation.

Table of one hundred weeds.—Continued.

Common names.	Technical name.	Where injurious.	Duration.	Time of flowering.	Time of seeding.	Color, sizes, and arrangement of flowers.	Methods of propagation and distribution of seed.	Place of growth and products injured.	Methods of eradication.
Rib grass, black plantain, buckhorn, deer tongue, English plantain, lance-leafed plantain, ripple grass.	Plantago lanceolata.	Nearly everywhere.	Perennial.	June to October.	July to November.	White; 1/16 in. spike.	Seeds; crown-forming roots.	Everywhere; all crops.	Clean seed; cultivation.
Running brier, dewberry, low blackberry	Rubus villosus....	Maryland to North Carolina.	....do.....	May to July.	June to August.	White; 1 in.; solitary.	Seeds; birds; rootstocks.	Fields; all crops.	Cultivation; smothering crops.
Russian thistle, Russian cactus, Russian saltwort, Russian tumbleweed.	Salsola kali tragus	Minnesota to Colorado.	Annual...	July to September.	August to November.	Purplish; 1/4 inch; solitary.	Seeds; wind.....	Everywhere; small grain.	Cultivation; grazing; mowing for hay; burning.
Shepherd's purse, mother's heart, pickpurse, toothwort.	Bursa bursa-pastoris.	Everywhere..	....do.....	March to December.	May to December.	White; 1/16 in.; raceme.	Seeds..........	Everywhere; all crops.	Cultivation.
Small carrot, bristly carrot, Southern wild carrot.	Daucus pusillus..	Georgia to Arizona.	....do.....	June to July.	July to August.	White; 1/8 in.; umbel.	Seeds; animals; wind.	....do.........	Prevention of seeding; cultivation.
Smartweed, swamp persicaria, shoestrings.	Polygonum amphibium emersum.	Ohio to Nebraska.	Perennial.	July to August.	August to September.	Pink; 1/16 in.; spike.	Seeds; rootstocks.	Lowland corn, grain.	Do
Sneezeweed...........	Helenium autumnale.	N. Carolina to Texas.	....do.....	July to September.	August to October.	Yellow; 1/2 in.; head.	....do..........	Meadows; pastures.	Cultivation.
Sorrel, field sorrel horse sorrel, red sorrel, sheep sorrel, sourweed.	Rumex acetosella.	Nearly everywhere.	....do.....	May to October.	June to November.	Red; 1/8 in.; panicle.	Seed, in clover seed; rootstocks.	....do.........	Cultivation; smothering crops.
Sow thistle, field sow thistle, perennial sow thistle.	Sonchus arvensis.	New England to Wisconsin.	....do.....	July to October.	August to November.	Yellow; 3/4 in.; heads.	Seeds; wind; creeping roots.	Meadows; pastures; grain-fields.	Thorough cultivation and smothering crops.
Spanish needles, bur marigold, beggarticks	Bidens bipinnata.	Everywhere..	Annual...	June to September.	July to November.	....do.........	Seeds; animals.	Waste land; pastures.	Prevention of seeding.
Spiny amaranth, spiny careless weed, red careless weed.	Amaranthus spinosus.	Virginia to Texas.	....do.....	July to November.	August to December.	Green; 1/16 in.; spikes.	Seeds..........	....do.......	Do.
Spiny nightshade......	Solanum aculeatissimum	N. Carolina to Mississippi.	....do.....	June to September.	July to October.	White; 1 in.; raceme.	....do..........	Waste places; pastures.	Prevention of seeding; cultivation.
Spiny cocklebur, Bathurst bur, Chinese thistle, dagger cocklebur.	Xanthium spinosum.	Maryland to Texas and California.	....do.....	July to October.	August to November.	Green; 1/8 in.; head.	Seeds; animals.	Waste land; pastures; wool.	Do.
Squirrel tail, foxtail, wild barley.	Hordeum jubatum	Texas to Utah	....do.....	June to September.	July to October.	Green; spike..	Seeds; wind; animals.	Pastures......	Do.

Star thistle, Texas thistle.	Centaurea americana.	Texas to Oklahoma.	....do.....	June to August.	July to September.	Purple; 2 inches; heads.	Seeds; wind	Cultivated land.	Do.
Stubble spurge, spotted spurge.	Euphorbia nutans.	Maryland to Missouri.	....do.....	July to October.	August to November.	White; 1/4 in.; cyme.	Seeds...........	....do.........	Prevention of seeding; burning stubble.
Sunflower, common sunflower.	Helianthus annuus.	Nebraska to Louisiana.	....do.....	July to September.	August to October.	Yellow; 4 inches; heads.	....do..........	....do.........	Prevention of seeding.
Tarweed...............	Madia sativa.......	Washington to California	....do.....	May to October.	June to November.	Yellow; 1/2 in.; heads.	Seeds; animals..	Roadsides; cultivated land.	Prevention of seed-burning; burning.
Toadflax, butter and eggs, devil's flax, impudent lawyer, ramstead, snapdragon.	Linaria linaria.....	New England to Wisconsin.	Perennial..	July to October.	August to November	Yellow; 1/2 in.; raceme.	Rootstocks; seeds.	Meadows; pastures.	Cultivation; heavy cropping.
Teasel, English thistle, fuller's card, Hutton-weed, Indian Thistle.	Dipsacus sylvestris.	Ohio to Tennessee.	Biennial...	July to September.	August to October.	White; 1 in.; head.	Seeds...........	....do.........	Prevention of seeding; cultivation.
Trefoil, black medic, nonesuch.	Medicago lupulina.	New York to Virginia.	Annual....	March to December.	April to December.	Yellow; 1/4 in.; head.	Seeds; in clover seed.	Meadows; lawns.	Clean seed; cultivation.
Tumbleweed, pigweed.	Amaranthus graecizans.	Minnesota to Kansas.	....do.....	August to September.	August to October.	Green; 1/16 in.; spike.	Seeds; wind	Cultivated land.	Prevention of seeding; burning.
Vipers bugloss, blue thistle, blueweed.	Echium vulgare..	New York to North Carolina.	Biennial...	June to October.	July to November.	Blue; 1/2 in.; thyrsus.	Seeds...........	Meadows; pastures.	Alternate cultivation and heavy cropping.
Wheatthief, corn gromwell, field gromwell, pigeonweed, redroot, stone seed.	Lithospermum arvense.	Michigan to Ohio.	Annual....	June to September.	July to October.	White; 1/4 in.; solitary.	Seeds; in grain seed.	Grainfields.....	Sowing clean seed; cultivation with hoed crops.
White heath aster, frostweed aster, steelweed, tanglefoot, fall aster.	Aster ericoides....	Maryland to Indiana.	Perennial..	September to November.	September to December.	White; 1/3 in.; head.	Seeds; wind	Meadows and pastures.	Mowing; grazing with sheep; rotation of crops.
Wild buckwheat, black bindweed.	Polygonum convolvulus.	Michigan to North Dakota.	Annual....	June to September.	July to October.	White; 1/4 in.; raceme.	Seeds; wind; animals.	Grain and corn-fields.	Sowing clean seed; cultivation.
Wild carrot, bird's nest, devil's plague, Queen Anne's lace.	Daucus carota.....	New England to Virginia.	Biennial...	June to October.	July to November.	White; 1/8 in.; umbel.	Seeds; animals; wind.	Meadows; pastures.	Grubbing in fall; cultivation.
Wild gourd, calabazita.	Cucurbita perennis.	California to New Mexico	Perennial..	April to July.	June to September.	Yellow; 3 inches; solitary.	Seeds...........	Cultivated land.	Killing the roots with coal oil.
Wild oats.............	Avena fatua.......	Minnesota to Oregon.	Annual....	July to August.	July to September.	Green; 3/4 in.; panicle.	Seeds; in seed oats.	Oat fields......	Sowing clean seed; burning; pasturing.
Wild garlic, field garlic, crow garlic, wild onion.	Allium vineale.....	Pennsylvania to South Carolina.	Perennial..	....do.....	August to September	White; 1/8 in.; umbel.	Bulblets; seeds.	Everywhere; dairy products; grain.	Alternate cultivation and heavy cropping.
Wild parsnip, queen-weed.	Pastinaca sativa...	New England to Wisconsin	Biennial...	June to September.	July to October.	Yellow; 1/8 in.; umbel.	Seeds...........	Meadows; pastures.	Prevention of seeding; cultivation.

Table of one hundred weeds.—Continued.

Common names	Technical name.	Where injurious.	Duration.	Time of flowering.	Time of seeding.	Color, size, and arrangement of flowers	Methods of propagation and distribution of seed.	Place of growth and products injured.	Methods of eradication.
Yellow daisy, brown-eyed Susan, cone flower, niggerhead ox-eye daisy.	Rudbeckia hirta..	New England to Ohio	Biennial..	June to August.	July to September.	Yellow; 1 in.; head.	Seeds..........	Meadows; pastures.	Prevention of seeding; cultivation.
Yellow dock, bitter dock, broad leaved dock.	Rumex obtusifolius	New England to Wis.	Perennial	July to September.	August to October.	Green; ⅙ in.; raceme.	.......do.......	.......do......	Do.
Yellow dog fennel, bitter weed.	Helenium tenuifolium.	Texas to N. Carolina.	Annual...	July to October.	August to November.	Yellow ½ in head.	.... do.......	Waste land; pastures; dairy products.	Do.
Yellow melilot, yellow sweet clover.	Melilotus officinalis.	Maryland to Michigan.	Biennial..	June to September.	July to October.	Yellow; ⅙ in.; Spike.	Seeds; in hay and clover seed.	Dry meadows and pastures.	Cultivation; increased fertilization.

—(Farmers' Bulletin No. 28.)

AUTHORITIES CONSULTED ON WEEDS: U. S. Dep't Agr. F. B. 28; B. P. I. B. 100; Iowa B. 70; Man. B. 2; Cornell B. 9; Ohio B. 175; Tenn. B. 2 Vol. VIII; Md. B. 155; Kan. B's. 38, 50, 52, 57, 66, 76 and 80; N. D. B. 62; Ohio B. 83 and Cir. 102; Wyo. 5th Ann'l Rep't; N. D. B. 2 and 56; Minn. B. 33 and 95; Penn. B. 58; Ill. B. 35; N. M. B. 13; R. I. B. 133; Ariz. B. 22; Tenn. B. 3 Vol. I.; Nev. B. 38; F. B. 86; Mont. 45; F. B. 188; Colo. 113; Ia. B. 14; Ia. B. 70; Wyo. B. 31; Ont. Dep't Agr. B. 168; Honolulu B. 25.

WEEDS USED IN MEDICINE.

Too much emphasis can not be placed upon the importance of carefully and thoroughly drying all crude drugs, whether roots, herbs, leaves, barks, flowers, or seeds. If insufficiently dried, they will heat and become moldy in shipping, and the collector will find his goods rejected by the drug dealer and have all his trouble for nothing. Another important matter to be considered in collecting drugs for market is freedom from foreign substances. All drugs should be clean and wholesome looking and contain no admixture of fragments of other plants, stones, dirt, or other impurities. A bright natural color is extremely desirable in leaves, herbs, and flowers, and adds much to the salability of the product. Roots may be cleaned by washing, but leaves, herbs, and flowers should never be washed. It is important also to collect drugs in proper season only. Neglect in this respect will bring nothing but disappointment to the gatherer, as drugs collected out of season not only are not acceptable to the dealer on account of inferior medicinal qualities, but there will also be, in the case of roots, a greater amount of shrinkage in a root dug during the growing season than will take place when it is collected after growth has ceased.

The collector should be sure that the plant he is collecting is the right one. There are many plants that closely resemble one another, yet one may possess medicinal properties and the other be absolutely useless. Again, a plant may contain very poisonous principles, and if represented to be something else, it might of course do untold injury. It would therefore be best, where any doubt exists, to send a specimen of the entire plant, including leaves, flowers, and fruits, to a drug dealer or to the nearest State experiment station for identification.

After washing, the roots should be carefully dried. This can best be accomplished by exposing them to light and air (not direct sunlight) on racks or shelves, or on clean, well-ventilated barn floors or lofts. They should be spread out thinly and turned occasionally from day to day until completely cured. When this point is reached, in perhaps three to six weeks, the roots will snap readily when bent. During the curing process the roots, if dried out of doors, should be placed under shelter at night and upon the approach of rainy weather.

With some roots additional preparation is required, such as slicing and the removal of fibrous rootlets. Wherever this is necessary mention will be made of it under the descriptions of the different plants. In general, it may be said that large roots should always be split or sliced when green in order to facilitate drying.

Barks.—The plants considered in this chapter do not furnish medicinal barks, but inasmuch as there are certain sections of the country where trees furnishing such barks are rather abundant, directions for their collection may not be out of place here.

Barks of trees should be gathered in spring, when the sap begins to flow, but may also be peeled in winter. In the case of the coarser barks (as elm, hemlock, poplar, oak, pine, and wild cherry)

the outer layer is shaved off before the bark is removed from the tree, which process is known as "rossing." Only the inner bark of these trees is used medicinally. Barks may also be cured by exposure to sunlight. Moisture must be avoided.

Leaves and Herbs.—Leaves and herbs should be collected when the plants are in full flower. It is very desirable that they retain their bright green color after curing, and this can be done by careful drying in the shade. In the collection of leaves the whole plant may be cut and the leaves may be stripped from it, rejecting the stems as much as possible. In the case of herbs the coarse and large stems should be rejected and only the flowering tops and more tender stems and leaves included. All grasses, bits of other plants, and other foreign substances should be carefully removed, as well as dead, shriveled, diseased, and discolored specimens.

Both leaves and herbs should be spread out in thin layers on clean floors, racks or shelves, in the shade but where there is free circulation of air, and turned frequently until thoroughly dry. Moisture will darken them. The same precautions that are necessary in curing roots apply here also, so far as placing them under cover to avoid dew or rain is concerned.

Flowers.—Flowers are collected when they first open or immediately after—not when they are beginning to fade. To preserve the bright natural color as nearly as possible they should be carefully dried in the shade, in the same manner as directed for leaves and herbs.

Seeds.—Seeds should be gathered just as they are ripening, before the seed pods open, and should be winnowed in order to remove fragments of stems, leaves, and shriveled specimens.

Disposal of the Drugs.—Samples representative of the lot of drugs to be sold should be sent to the nearest commission merchant, general store, or drug store, for inspection and for quotation on the amount of drug that can be furnished, or for information as to where to send the article. The size of the sample depends, of course, upon the kind of drug; from 3 to 4 ounces—or, say, at least a good handful—should be submitted. The package containing the sample should be plainly marked as regards contents, and the name and address of the sender given. In writing to the different dealers for information and prices, it should be stated how large a quantity of a particular drug can be furnished and how soon this can be supplied. In no case should the entire lot of collected drugs be sent to dealers without preliminary correspondence. The collector should bear in mind that freight is an important item, and it is best, therefore, to address such dealers as are nearest to the place of production. When ready for shipment, crude drugs may be tightly packed in burlap or gunny sacks, or in dry, clean barrels.

DESCRIPTION OF PLANTS.

The plants here included are burdock, dandelion, the docks, couch grass, and pokeweed (principally root drugs); foxglove, mullein, lobelia, tansy, gum plant, scaly grindelia, boneset, catnip, horehound, yarrow, fleabane, blessed thistle, jimson weed, and poison

hemlock (of which either the leaves, flowers, herb, or seeds are used in medicine); and also wormseed, and black and white mustards, of which the seeds only are used.

Descriptions of these plants (not already described in their classification as weeds elsewhere in this work) follow, together with the common names by which they are known in different localities, the habitat (or, in other words, the kinds of places or soils in which they are likely to be found), their geographical range, information as to the parts to be collected, their uses, the extent to which they are imported and the prices usually paid by dealers.

With the exception of the figures for dandelion and mustard, which were obtained from the Bureau of Statistics of the Department of Commerce and Labor, the imports are based on estimates furnished by dealers, and the prices per pound, while serving to give an idea as to what may be expected for the drugs, will vary from year to year, depending principally upon supply and demand.

There are of course a large number of plants used in medicine that are not included in this article, which is intended to cover only such medicinal plants as may be classed as weeds.

Burdock (*Arctium lappa*).—Cockle button, cuckold dock, beggars' buttons, hurr-bur, stick button, hardock, and bardane. The root alone is recognized in the United States Pharmacopœia, but there is a limited demand for burdock seed, and the leaves also are employed. Burdock roots and seeds are used in blood and skin diseases, and the leaves externally as a cooling poultice for swellings and ulcers, the latter being employed only in the fresh state. About 50,000 pounds of lappa or burdock root are imported annually, and the best root is said to come from Belgium, where great care is exercised in its collection. The price of the root ranges from 3 to 8 cents per pound, and that of the seed from 5 to 10 cents.

Dandelion (*Taraxacum taraxacum*).—Blow-ball, cankerwort, doon-head-clock, fortune-teller, horse gowan, Irish daisy, yellow gowan, one o'clock. Dandelion is distributed as a weed in all civilized parts of the world, and in this country is naturalized from Europe. With the exception of the South, it is very abundant throughout the United States in fields and waste places, and it is especially troublesome in lawns and meadows. The root of dandelion is used medicinally. It is a large taproot, sometimes 20 inches long, thick and fleshy, dull yellow or brownish on the outside, white inside, practically without odor, and bitter. Dandelion is often used as a tonic in diseases of the liver and in dyspepsia.

The best time for digging dandelion root is from July to September. The annual import of dandelion root into the United States amounts to over 100,000 pounds. The price per pound ranges from 4 to 6 cents.

Docks (*Rumex species*).—Several species of docks possess medicinal properties. Among these are the yellow dock (*Rumex crispus*), the broad-leaved dock (*R. obtusifolius*), and the yellow-rooted water dock (*R. britannica*), all more or less abundant

throughout the United States. Other species are also recognized as possessing value in medicine, but those above mentioned are the kinds generally collected.

The root, which is the part to be collected for medicinal purposes, is very similar in all of these species of dock, usually from 8 to 12 inches long, fleshy, often somewhat branched, the outside dark reddish brown with a rather thick bark, internally yellowish. The roots should be collected in late summer or autumn. The docks are largely employed for purifying the blood and as a remedy in skin diseases. Rumex or dock roots are imported into this country to the extent of about 125,000 pounds annually. The price ranges from 2 to 8 cents per pound.

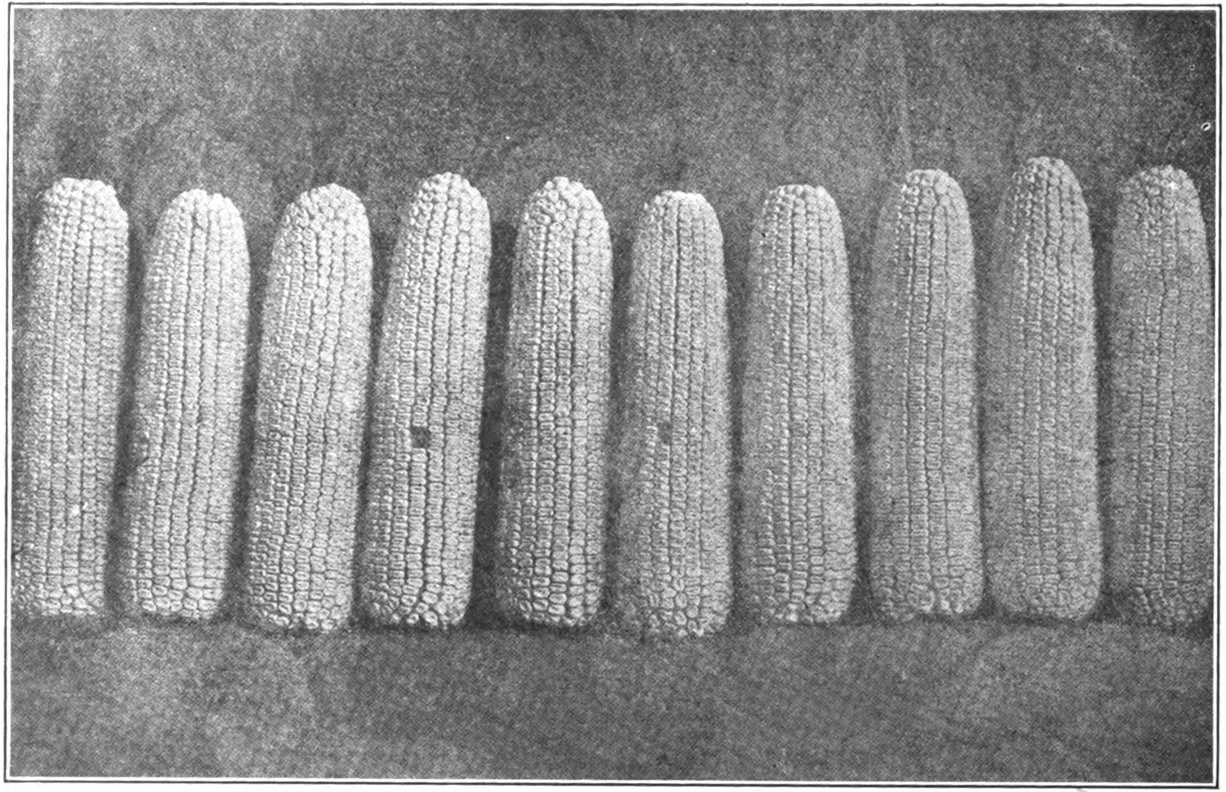
Couch Grass (*Agropyron repens*).—Dog-grass, quick-grass, quack-grass, quitch-grass, scutch-grass, twitch-grass, witch-grass, wheat-grass, Chandler's grass, creeping wheat-grass, devil's-grass, durfa-grass, Durfee-grass, Dutch-grass, Fin's grass, quake-grass, Couch grass is now a most troublesome pest in cultivated ground, causing the farmer a loss of thousands of dollars annually by taking possession of fields, and crowding out valuable crops. The most important part of this grass, not only agriculturally but also pharmaceutically, is its long, tough rhizome or root-stock, creeping along underneath the ground and pushing in every direction.

One of the best methods of destroying this weed is to plow up the roots and burn them. They need not be burned, however, but may be saved and prepared for the drug market. In the drug trade this plant is generally known as dog grass or triticum. As found in the stores, it is in the form of small, angular pieces, about one-eighth to one-fourth of an inch long, straw colored, shining, and hollow. These pieces are odorless but have a somewhat sweetish taste. The fluid extract prepared from dog grass is used in kidney and bladder troubles. Couch grass is almost wholly an imported article, some 250,000 pounds coming into this country annually from Europe. The price is about 3 to 7 cents per pound.

Pokeweed (*Phytolacca americana*).—Poke, pigeon-berry, garget, scoke, pocan, coakum, Virginian poke, ink-berry, red-ink-berry, American nightshade, cancer jalap, redweed. For medicinal purposes the berries and roots are employed. Both of these should be collected when the berries are fully mature, which usually occurs about two months after flowering. The clusters of berries should be carefully dried in the shade. They are poisonous, have no odor, a sweetish taste at first, then acrid. It should be gathered in the latter part of the fall, thoroughly cleaned, cut into transverse slices, and carefully dried.

Both the berries and roots are alterative, act upon the bowels and cause vomiting, and preparations made from them are used in treating various diseases of the skin and blood, and in certain cases in relieving pain and allaying inflammation. Phytolacca or pokeroot brings from 2 to 5 cents per pound, and the dry berries about 5 cents per pound.

Foxglove (*Digitalis purpurea.*)—Purple foxglove, thimbles,



AN EXCELLENT LOT OF SEED EARS. DEPT. OF AGR.
(See pages 401-408)

fairy cap, fairy fingers, fairy thimbles, fairy bells, dog's finger, finger flower, lady's glove, ladyfingers, lady's thimble, popdock, flapdock, flopdock, lion's mouth, rabbit's flower, cottagers, throatwort, Scotch mercury. Foxglove was originally introduced into this country from Europe. The plant is in flower about June, and the long clusters of numerous tubular bell-shaped flowers are very showy. The clusters are terminal, and about 14 inches in length. Leaves of the second year's growth only are employed, and these should be collected when about two-thirds of the flowers have expanded. They should be very carefully dried in the shade and then kept in close boxes or barrels so as to keep out all moisture. The greatest care is necessary in curing, as the leaves soon lose their medicinal properties if not properly dried. Preparations made from foxglove are of great value in heart troubles, but they are poisonous and should never be used except on the advice of a physician. From 40,000 to 60,000 pounds of digitalis or foxglove are annually imported into this country from Europe, where the plant is cultivated. The American-grown product has so far never been used, but leaves from the wild American plant have been assayed and found to be equally as good as the European article. The price per pound ranges from about 6 to 8 cents.

Mullein (*Verbascum thapsus*).—Great mullein, velvet or mullein dock, Aaron's rod, Adam's flannel, blanket leaf, bullock's lungwort, cow's or clown's lungwort, candlewick, feltwort, flannel leaf, old-man's flannel, hare's beard, hedge taper, ice leaf, Jacob's staff, Jupiter's staff, lady's foxglove, Peter's staff, shepherd's club, torches, torchwort, velvet plant. As the leaves and flowers are to be collected at the time when the plant is in bloom, the propagation of the plant by the dissemination of its seed is prevented. The leaves are cured in the usual manner. They are practically inodorous, and have a somewhat bitter, mucilaginous taste.

It is very desirable to have the flowers retain their bright yellow color; they must therefore be thoroughly dried, and then kept free from moisture in well-stoppered bottles. They readily absorb moisture and if allowed to become damp will turn black. The corolla (petals), with the adhering stamens only, is dried, the calyx being rejected. Flowers have a sweetish, pleasant odor.

Mullein is used in coughs and catarrh, to quiet nervous irritation, and to relieve pain and inflammation. According to some authors, the dried leaves are often smoked like tobacco to relieve nasal catarrh and throat affections. About 5,000 pounds of verbascum or mullein flowers are annually imported, chiefly from Germany, in which country this plant is cultivated. The leaves are also imported to a small extent. The price paid for the leaves ranges from 2½ to 5 cents per pound, and that for the flowers may range from 25 to 75 cents per pound.

Lobelia (*Lobelia inflata*).—Indian tobacco, wild tobacco, bladder pod, asthma weed, gagroot, pukeweed, vomitwort, low belia, eyebright. This poisonous weed occurs nearly everywhere throughout the United States, being most plentiful east of the Mississippi

River, and thriving in dry, clayey, or siliceous soil in sunny situations along roadsides, and in old fields and pastures. The erect leafy stem of this annual herbaceous plant is from 1 to 3 feet high, from a fibrous root. It is simple and rough-hairy below, smooth, above, and bears a few short branches. The entire plant contains an acrid milky juice. It belongs to the bellflower family (*Campanulaceæ*). The leaves and flowering tops are used in medicine, and there is also a good demand for the seed. The leaves and tops should be gathered after some of the pods have become inflated, should be dried in the shade, and when dry kept in covered vessels. The dried leaves and tops have a rather disagreeable, somewhat sickening, odor, and the taste, though mild at first, soon becomes strongly acrid and nauseous. The seeds are extremely minute, and each capsule is said to contain from 450 to 500 seeds. Lobelia is an expectorant, acts upon the nervous system and bowels, causes vomiting, and is poisonous. The price paid for the dried leaves and tops ranges from 3 to 8 cents per pound, and that for the seed from 15 to 20 cents per pound.

Tansy (*Tanacetum vulgare*).—Bitter buttons, ginger plant, parsley fern, scented fern. Tansy was originally introduced into this country as a garden plant from Europe, where it is native. It has now escaped from cultivation and is found as a weed along waysides and fences in many places from New England to Minnesota and southward to North Carolina and Missouri. This strong-scented perennial herb belongs to the aster family. (*Asteraceæ*). The stout, erect stem is from 1½ to 3 feet high, branching near the top, somewhat reddish, and usually smooth. Tansy is in flower from July to September, and the roundish but flat-topped yellow flower heads are produced in dense terminal clusters. At the time of flowering the leaves and tops are collected for medicinal purposes and are dried in the usual manner. The odor of tansy is strongly aromatic and the taste bitter. In drying, tansy loses about four-fifths of its weight. Tansy is employed in derangements of women, and has stimulant and tonic properties. It is also used for expelling worms. This drug is poisonous and has been known to produce fatal results. About 30,000 pounds of tanacetum or tansy are imported annually. The price paid per pound ranges from 3 to 6 cents.

Gum Plant (*Grindelia robusta*).—The gum plant occurs in the States west of the Rocky Mountains. The entire plant is covered with a resinous substance, which gives it a gummy, varnished appearance, whence its common name, gum plant, is derived.

This perennial of the aster family of plants has an erect habit of growth, and sends up a round smooth stem about a foot and a half high, narrowly grooved and freely branching near the top, each branch terminating in a large yellow flower. The branches near the flower heads have a slightly reddish appearance. The flowering tops and leaves of this and of the scaly grindelia are collected indiscriminately, and bring from 5 to 12 cents per pound.

They are used in asthma and similar affections, and externally in cases of poisoning by poison ivy.

Scaly Grindelia (*Grindelia squarrosa*).—This has a wider distribution than the gum plant, being quite common on the plains and prairies from the Saskatchewan to Minnesota, south to Texas and Mexico, and westward to California. This species is very similar to the gum plant, with the exception that it is smaller and does not have the gummy appearance of the former. The leaves and flowering tops are collected with those of the gum plant, *Grindelia robusta*.

Boneset (*Eupatorium perfoliatum*).—Thoroughwort, crosswort, wood boneset, teasel, ague-weed, feverwort, thorough-stem or thorough-wax, vegetable antimony, sweating plant, Indian sage, wild sage, tearal, wild Isaac. Boneset delights in moist situations, and is common as a weed in clayey or sandy soil, in low, wet ground, and along the streams, on the edges of swamps and in thickets from the New England States west to Nebraska and south to Texas and Florida.

One of the features which will aid in recognizing this plant is the peculiar arrangement of the leaves. These are opposite each other and joined together at the base around the stem, and therefore have the appearance of a single leaf with the stem passing through the center of it. Boneset is a perennial herb of the aster family of plants (*Asteraceæ*), with stout, rough, hairy stems 1 to 5 feet high, from a horizontal, crooked root. The leaves and flowering tops are the parts used in medicine, and these should be collected when the plants are in flower, stripped from the stalk, and carefully dried. They lose about three-fourths of their weight in drying. The odor is faintly aromatic, the taste bitter and astringent. As indicated by the common names "ague-weed" and "feverwort," this is a popular remedy in fever and ague. It is used also in colds, dyspepsia, jaundice, and for toning up the system. In large doses it is an emetic and cathartic. Eupatorium or boneset leaves and tops bring from 2 to 8 cents per pound.

Catnip (*Nepeta cataria*).—Catmint, catrup, cat's wort, field mint. This very common weed is naturalized from Europe, and is found in rather dry soil in waste places and cultivated land. The erect, square stems of this perennial herb of the mint family (*Menthaceæ*) grow to a height of 2 to 3 feet, are branched, and somewhat whitish in appearance from the covering of fine white hairs. The flowering tops and leaves are to be collected when the plant is in flower and carefully dried. They have a strong mint-like odor and a bitter taste. The coarser stems and branches should be rejected. Catnip is used in derangements of women, as a mild stimulant and tonic, and has a quieting effect on the nervous system. Cataria or catnip is imported in but small quantities. The price paid for the flowering tops and leaves is from 2 to 8 cents per pound.

Horehound (*Marrubium vulgare*).—Houndsbene, marvel, marrube. Horehound has been naturalized from Europe, and has

escaped from gardens in this country. The entire plant has a whitish, woolly appearance, caused by the dense covering of hairs. It is a perennial plant, and as will be seen from the characteristic lip-shaped flowers, is a member of the mint family (*Menthaceæ*). The whole plant has a rather pleasant, balsamic odor. It is a bushy, branching herb, with fibrous roots sending up numerous woolly stems about 1 to 3 feet high, rounded below and four-angled above. The leaves are opposite each other. The leaves and tops are used in medicine. These should be gathered just before the herb is in flower, rejecting the coarse stalks, and should be dried in the shade in the usual manner. The balsamic odor diminishes in drying. The herd has a bitter, persistent taste. Horehound is well known as a remedy for colds, and is also used in dyspepsia and for expelling worms. A considerable quantity of marrubium or horehound is imported, about 125,00 pounds coming into this country annually. Three to 8 cents is the price paid per pound.

Blessed Thistle (*Cnicus benedictus*).—Holy thistle, bitter thistle, Our Lady's thistle, St. Benedict's thistle, cursed thistle, spotted thistle. This weed has been introduced from Europe and occurs in stony, uncultivated localities and waste places in the Southern States and in California and Utah. It is an annual plant belonging to the aster family (*Asteraceæ*). The round stems are erect, about 1 to 2 feet high, branched, and rather woolly. The leaves are more or less hairy. The leaves and tops should be collected when the plant is in flower, about June, thoroughly and quickly dried, and kept in a vessel from which moisture, light, and air should be excluded. They have a somewhat disagreeable odor and the taste is very bitter. Blessed thistle is employed in fevers, dyspepsia, and as a tonic to restore the appetite. This plant is cultivated in Germany, from which country it is imported to a limited extent. The price per pound ranges from 8 to 10 cents.

Yarrow (*Achillea millefolium*).—Milfoil, thousand leaf, thousand-leaved clover, green arrow, gordoloba, nose-bleed, bloodwort, carpenter's grass, sanguinary, soldiers' woundwort, old man's pepper. This herb is a common weed from the New England States to Missouri and in scattered localities in other parts of the country, occurring along roadsides, in old fields, pastures, and meadows. Yarrow is a perennial belonging to the aster family (*Asteraceæ*). It is about 10 to 20 inches in height, its numerous dark-green feathery leaves divided into very fine crowded parts.

The odor of yarrow is strong and aromatic, very similar to that of chamomile, and the taste is sharp and bitter. When this plant is eaten by cows its bitter taste and strong odor are imparted to dairy products. The entire plant is collected when in flower, and is carefully dried. The coarser stems should be rejected. The plant loses nearly four-fifths of its weight in drying. Yarrow is a stimulant tonic, acts upon the bladder, and checks excessive discharges. This is an imported article, though not brought into the United States in large quantities. The price of *achillea*, or yarrow, ranges from 2 to 5 cents per pound

Canada Fleabane (*Erigeron canadensis*).—Horseweed, colt's tail, scabious, prideweed, bitter weed, fireweed, blood-stanch, cow's tail. This weed is common in damp, sandy soils in fields and waste places and along roadsides in many parts of the United States, especially throughout the northern Mississippi Valley. The entire herb is medicinal, and should be gathered during the flowering period and carefully dried. It has a faint, agreeable odor and a somewhat astringent and bitter taste. The fresh herb on distillation yields a volatile oil which is sold as oil of fleabane. The common name "blood stanch" indicates the use of this plant for arresting hemorrhages from various sources and the bleeding of wounds. It is useful also in diarrhea and dropsy. The price paid for *erigeron*, or fleabane, ranges from 6 to 8 cents per pound.

Jimson Weed (*Datura stramonium*).—Jamestown weed (from which "jimson" weed is derived), thornapple, stinkweed, stinkwort, devil's apple, mad-apple, devil's trumpet, fireweed, Jamestown lily, dewtry, apple of Peru. Both the leaves and seeds are medicinal. The leaves are collected at the time of flowering, the entire plant being cut or pulled up and the leaves stripped and dried in the shade. The unpleasant narcotic odor diminishes upon drying. The leaves are poisonous, cause dilation of the pupil of the eye, and are used principally in asthma. For the collection of the seeds the capsules should be taken from the plants when they are quite ripe, but still of a green color. The capsules should then be dried for a few days, when they will burst open and the seeds can be readily shaken out. These should now be carefully dried. The seeds like the leaves are poisonous and possess the same properties. Occasional cases of poisoning of children occur from eating the seeds of jimson weed and taking the flowers in their mouths. From 100,000 to 150,000 pounds of stramonium leaves (the name by which they are designated in the drug trade) are imported into this country annually, and about 10,000 pounds of seeds are imported. The leaves will bring from 2½ to 8 cents per pound, and *stramonium* seeds from 3 to 7 cents per pound.

Purple Thorn-apple.—The purple thorn-apple, technically known as *Datura tatula*, is very similar to the jimson weed, possesses the same properties, and is distinguished from it merely by its reddish stems and purplish flowers. The leaves and seeds may be gathered with those of the jimson weed.

Poison Hemlock (*Conium maculatum*).—Spotted parsley, St. Bennet's herb, bad-man's oatmeal, heck-how, wode whistle, cashes, bunk, poison parsley, spotted cowbane. The fruit and leaves are the parts used. The fruit should be collected while still green but full grown, which in most localities is some time in August. It should be dried in dark but well ventilated places, and then stored in tight cans or boxes where it will not be exposed to the action of light and air. The poison hemlock leaves should be collected when the plant is in flower, which will be in the second year of its growth. The stems should be rejected. Contrary to the usual method of drying leaves and herbs, the poison hemlock leaves may

be quickly dried in the sun and then kept in tightly closed vessels. The leaves will retain their green color if properly cured. The odor is still very disagreeable, but not so pronounced as in the fresh plant. This very poisonous drug is used in rheumatism, neuralgia, asthma, and in cases where the nervous system is in an excited condition. The imports of conium or poison hemlock seed amount to about 20,000 pounds annually, and from 10,000 to 20,000 pounds of the leaves are imported. The price paid for the seed is about 3 cents per pound, and for the leaves about 4 cents.

American Wormseed (Chenopodium ambrosioides).—Mexican tea, Spanish tea, Jerusalem tea, Jesuit tea, ambrosia. This strong-scented herb, naturalized in this country from tropical America, frequents waste places around dwellings and is found in streets, meadows, pastures, and grain fields from New England to Florida, and westward to California. American wormseed is an annual plant of the goosefoot family (*Chenopodiaceæ*), attaining a height of from 2 to 3 feet. The stem is grooved, usually much branched and leafy. From July to September the flowers are produced, followed throughout the autumn by the fruits, both of which are green and borne in crowded leafy spikes. The whole plant has a powerful, disagreeable odor, due to the essential oil which it contains. The entire leafy part of the plant is sometimes employed for the distillation of the oil, although the fruit alone is listed in the Pharmacopœia of the United States. The fruit is distilled for the oil, which it contains in large quantities. The fruits are in the form of small grains, about the size of a pin head, globular but slightly flattened, greenish, and inclosing the small shining black seeds. They have the same powerful odor as the plant, which does not diminish when the fruit is dried, and the taste is bitter and pungent. American wormseed is an anthelmintic; that is, it has the property of expelling worms.

The fruits of *Chenopodium anthelminticum,* another species of wormseed, are collected with those of the species just described. This plant is very similar to the American wormseed, the fruits being alike, and the only differences being that in *Chenopodium anthelminticum* the stem is slightly taller, from 2½ to 3½ feet high, the leaves are more coarsely toothed, the flowers are borne in more elongated, usually leafless spikes, the odor is more pronounced and disagreeable, and the range and distribution of the plant are more limited. Wormseed is cultivated to a considerable extent in parts of Maryland, where the distillation of the plant for the oil is carried on. In ordinary seasons the price paid for *chenopodium* or wormseed ranges from 6 to 8 cents per pound. The oil distilled from wormseed is at present selling at $1.50 per pound.

Black Mustard (*Brassica nigra*).—Brown mustard, red mustard. The tops may be pulled when most of the pods are nearly mature, but before they are ready to spring open. They should then be placed on a clean, dry floor or shelf, allowing the pods to ripen and dry out, when they will burst open and the seeds can be readily shaken out.

Mustard seed has no odor whatever when collected, not even when it is powdered in its dry state, but as soon as water is added in grinding it, the powerful, penetrating mustard odor is developed. The taste is sharp and pungent.

White Mustard (*Sinapis alba*).—Yellow mustard. White mustard is a weed found in cultivated land along waysides and fence rows, but is not so abundant nor so widely distributed as the black mustard. The seeds are to be collected in the same manner as those of black mustard. White mustard seed has no odor in its entire state, and when water is added in grinding it the odor does not become so pronounced as in the case of black mustard, neither is the taste so pungent. In medicine mustard seeds are used principally in the preparation of plasters and poultices. They are used also in dyspepsia, and in large doses act as an emetic. The imports into the United States of black and white mustard together during the fiscal year ended June 30, 1903, amounted to 5,302,876 pounds. The price ranges from 3 to 6 cents per pound for both the black and white mustard seeds.—(F. B. No. 188.)

POISONOUS PLANTS OF THE UNITED STATES.

Statistics in regard to poisonous plants are lacking on account of a general ignorance of the subject, and it is therefore impossible to form even an approximate estimate of the amount of damage done by them. The various species of water hemlock (*Cicuta*) kill a number of children each year. In the State of New Jersey two quadruple cases of water-hemlock poisoning were reported during the spring of 1896, which resulted fatally to two of the eight individuals affected. The number of cattle killed by one species of *Cicuta* in Oregon alone is estimated to be over 100 per annum. The damage caused by the well-known loco weed in Colorado was so large that the State paid out nearly $200,000 in bounties in an effort, unfortunately ineffectual, to exterminate the pest. The distress caused by poison ivy is being constantly experienced by thousands of individuals.

Recent investigations have been made of cases of poisoning which have been reported. By communicating with the physicians who had charge of each case, accurate and full data were obtained with regard to many plants.

All poisonous plants are not equally injurious to all persons, nor to all forms of life. The most familiar illustration of this fact is to be found in the action of poison ivy. It has no apparent external effect upon animals, and a few of them, such as the horse, mule, and goat, eat its leaves with impunity. It acts upon the skins of a majority of persons, but with varying intensity. Many people are probably wholly immune, but some lose their restraint power in middle life; others have been known to attain immunity from it to a very considerable degree. There is a similar variability in the effects of poisonous plants taken internally. The qualifications involved in the definition of a poisonous plant are numerous, and can not well be introduced into this work. It may suffice here to say that death in some cases is attributable not to any poison which the plant con-

tains but to immoderate or incautious eating, or to mechanical injury, such as is produced in horses by the hairs of crimson clover, which under certain conditions accumulate in large balls and obstruct the intestines, or to the effect of parasitic growths, such as ergot occurring on rye. Neither the clover nor the rye is poisonous.

Excluding all that operate in these ways, there is still a large number of poisonous plants which, on account of their limited area of growth, and sometimes of the uncertainty of knowledge concerning their evil effects, are comparatively little known. It is possible to consider only those which are known to be poisonous.

Fly Amanita, or Toadstool (*Amanita muscaria*).—Fly fungus, fly agaric, fly killer, deadly amanita, false orange amanita. The amanitas form the most typical genus of that group of fleshy fungi which bear radiating plates or gills on the under surface of the cap. In the early stages of growth the amanitas are egg-shaped and are entirely enveloped by a white fleecy or cobwebby covering, which is ruptured as the stem lengthens. In a few species this covering adheres in loose, corky patches to the top of the cap, but sometimes it slips away from the cap entirely and forms a more or less continuous sheathing cup at the base of the stem. This fleecy covering and the invariably bulbous base of the stem are the most important characteristics of the genus, while the varying appearance of the former after rupture helps to distinguish the species. These features are well pronounced as a rule, but sometimes it requires some searching to find the cup. The fly amanita is a handsome, robust species, 4 to 16 inches high. It is singularly free from larval pests and the usual signs of decay, and is highly attractive in appearance, taste, and smell. In its early stages the shape of the cap is very strongly convex, but by gradual expansion it becomes flat and even concave. It is invariably warty. In color it varies from nearly white through all shades of yellow to a bright red. From the common mushroom (*Agaricus campestris*) the fly amanita is easily distinguished by having white instead of purple gills and spores, by its warty cap and bulbous stem, and by its place of growth, the meadow mushroom never appearing in forests. The fly amanita is abundant in several localities in the United States. It is the best known of all the poisonous species. As a fly poison it has been used in Europe for hundreds of years, and the origin of its use in northeastern Asia as an intoxicant is probably not much more modern. Poisoning is, however, not so frequently caused by it as by the closely related and more poisonous death cup (*Amanita phalloides*), yet many cases have been recorded. Cattle are poisoned as well as men, and it is supposed that their flesh is thus rendered unwholesome. The symptoms come on generally within two hours after the fungus is eaten, and consist in a less rapid beating of the heart and an extreme difficulty in breathing. After two or three hours there is a profound stupor, often preceded or accompanied by cold sweats and nervous phenomena—such as giddiness, double vision, and lockjaw. Vomiting sometimes gives relief to the patient, but it is often difficult to produce this effect after stupor has set in, even with the most powerful emetics. This condi-

tion may last from eight to ten hours in milder cases, and one or two days in more serious cases. Death follows in from eighteen hours to two or three days, from a gradual weakening and a final stoppage of the heart's action. There is very little danger of finding either the fly amanita or the death cup (the best known name for either is toadstool) mixed with the meadow mushrooms sold by regular dealers or brought into market by people who make it a business to do so, but diligence should be maintained by market inspectors in scrutinizing all new kinds of fungi brought in for general sale.

Death Cup (*Amanita phalloides*).—This is another variety of the toadstool. It is not so large or brightly colored as the fly amanita, but is nevertheless decidedly attractive to the inexperienced and experimenting epicure. When fresh it has neither a disagreeable odor nor taste, nor has it any ill appearance due to the presence of larvæ. It grows from 3 to 6 or 8 inches high, and has a smooth, satiny cap, which is strongly convex at first, finally becoming flat or slightly concave. It is usually white or straw-colored, but may be green, light brown, yellow, or even spotted when found growing in dense shade. The stem is white and nearly smooth. The cup is, however, invariably present. In connection with the white gills and spores and the bulbous base, it is the distinguishing feature of the species. In general shape the death cup is somewhat like the common mushroom, but it is very much more like another species, the smooth lepiota (*Lepiota naucina*), which is considerably sought after by expert epicures. The lepiota, like the death cup, has a smooth, satiny cap, white gills, and white spores, but it is distinguished by the absence of a sheathing cup and by the ball-and-socket attachment of the stem to the cap, as well as by its occurrence chiefly in meadows. From the common mushroom the death cup may be at once distinguished by its cup, by its white gills and spores, and by its growing in woods instead of in meadows. The death cup is the most poisonous of all the fleshy fungi. In a few instances the mere handling of the plant causes serious trouble. A third part of an uncooked medium-sized cap proved fatal to a boy 12 years of age. The symptoms are characteristic; no bad taste warns the victim, and usually the first effects do not appear until from nine to fourteen hours after eating. There is then considerable pain, and there may be cramps in the legs and other nervous phenomena, such as convulsions and even lockjaw. In a few cases there are spasms. The pulse is weak and either quick or slow in its action. The pupils of the eyes are sometimes dilated. The abdominal pain is rapidly followed by nausea, vomiting, and extreme diarrhea, the discharges assuming the peculiar "rice water" condition characteristic of cholera. The latter symptoms are persistently maintained, generally without loss of consciousness, until death ensues, as it does in from two to four days. The vernal amanita or destroying angel (*Amanita verna*) is regarded by some experts as identical with the death cup. It has the same poisonous action.

American False Hellebore (*Veratrum viride*).—American white hellebore; white hellebore; false hellebore; swamp hellebore; Indian poke; meadow poke; poke root (in N. H.); Indian uncus;

puppet root; earth gall; crow poison; devil's bite; duckretter; itch weed; bugbane; wolfsbane; bear corn. It is a stout, herbaceous, simple-stemmed perennial, 2 to 7 feet high, with a fleshy root 1 to 3 inches long, large, plaited stemless leaves of varying size, and a large, loose, terminal cluster of yellowish-green flowers which blossom from May to July. It grows in wet meadows and along mountain brooks. Cases arise mainly from overdoses in medicine, but instances of accidental poisoning are reported for man and for various animals and birds. The seeds have been specially mentioned as poisonous to chickens. Some animals, such as the horse, are poisoned by eating the leaves, but animals such as the sheep and elk, which chew the cud, seem to relish the plant, and eat it with apparent impunity. The root has been eaten and often with fatal results by man. The poison operates chiefly against the action of the heart and spinal cord, both of which it tends to paralyze. It has also a violent, although somewhat tardy, emetic and cathartic effect, a property which is often effective in expelling the poison from the system before it accomplishes its deadly work. The chief effects on the system are burning in the throat, an increased flow of saliva, defective vision, vomiting, diarrhea, severe headache, dizziness, weak pulse, labored breathing, and profound prostration. Death is caused by paralysis of the heart.

Pokeweed (*Phytolacca decandra*).—Poke; poke root; garget; pigeon berry; cocum; jalap; skoke; American nightshade; crowberry; cancer root; chongras (La.); redweed; red-ink plant; pocan bush. A smooth, rank, succulent perennial, 6 to 9 feet high, with a thick half-woody root, purplish stems, large alternate leaves, and numerous elongated clusters of small greenish-white flowers, which blossom throughout the summer, and are followed in autumn by shining purple-black berries. The pokeweed is a well-known plant and has many household uses, but some chemical or mechanical manipulation seems necessary to prevent ill effects when it is eaten. The root and the alcoholic extract of the fruit are quite commonly used as a household remedy for the itch and other skin diseases and for rheumatism. Most instances of poisoning arise from overdoses when the plant has been used as a medicine, but there are also accidental cases due to the eating of the root, which has been variously mistaken for that of the parsnip, artichoke, and horseradish. A few fatal cases of poisoning of children have been attributed to the fruit, but whether death was really due to the seed or the pulp is somewhat uncertain. The evidence is chiefly against the seed, for it is known to contain a poisonous substance. Pokeweed is a violent but slow-acting emetic, vomiting beginning only after about two hours. It also affects the nerves and muscles, producing retching, spasms, severe purging, and sometimes convulsions. Death is apparently due to the paralysis of the respiratory organs.

Corn Cockle (*Agrostemma githago*).—Cockle; rose campion; bastard nigelle; old maids' pink (N. H.); mullein pink (Nova Scotia); licheta (Vt.); crown of the field. A whitish, woolly an-

nual, 1 to 3 feet high, with an erect stem, showy, violet-red flowers, and numerous rough, black, irregularly rounded seeds. The poisonous constituent is very freely soluble in water, and possesses a sharp, burning taste. It has no odor, but when inhaled in the smallest quantity it produces violent sneezing. When briskly shaken with water it froths like soap. The poison is found in nearly all parts of the plant, but mainly in the kernel of the seed.

Cases of poisoning have been noted among all sorts of poultry and household animals, but are rarely due to any portion of the plant as found growing in the field. The poisoning is generally produced by a poor grade of flour made from wheat containing cockle seeds. Machinery is used to remove these seeds from the wheat, but the difficulty of separating them is so great that the result is not entirely accomplished. The general symptoms of acute poisoning are the following: Intense irritation of the whole digestive tract, vomiting, headache, nausea, vertigo, diarrhea, hot skin, sharp pains in the spine, difficult locomotion, and depressed breathing. Stupor sometimes sets in, and it may be followed by death. Chronic poisoning has not been closely studied in man, but experiments upon animals show chronic diarrhea and gradual depression, the animal losing vigor in breathing and in muscular movements until death ensues. Corn-cockle meal is easily detected in second and third class flour by the presence of the black, roughened scales of the seed coat.

Dwarf Larkspur (*Delphinium tricorne*).—Stagger-weed (Ohio). The genus Delphinium, formed by the larkspurs, is composed of erect herbs, with palmately lobed leaves, and an elongated cluster of showy flowers. These are commonly blue, and are further characterized by the absence of green parts, and the presence of a peculiar spur-like appendage. There are over 25 species native to the United States. Few have a very wide distribution, but some of the Western species are extremely abundant in their natural place of growth. They have a general reputation of being poisonous to cattle.

The dwarf larkspur is a smooth, simple-stemmed perennial, 6 to 12 inches high, with a tuberous root, deeply 5-parted leaves, and a long, loose cluster of blue (sometimes white) flowers, which appear in April and May. It grows in clayey soil and open woods, from Pennsylvania and the mountains of North Carolina to southern Minnesota. It is especially reported from Ohio as fatal to cattle in April, when the fresh leaves appear.

Wyoming Larkspur (*Delphinium geyeri*).—Poison weed. A somewhat hairy perennial, 10 to 20 inches high, with a large spheroidal tuft of rather thick, dull-green leaves, and a central column of deep azure-blue flowers. A common high prairie plant of Wyoming and northern Colorado. It is reported to be the most troublesome of the poisonous plants of Wyoming. Ranchmen suffer considerable loss from it, especially in early spring, when the dark green tufts of foliage are conspicuous features of the otherwise dry and barren landscape.

Purple Larkspur (*Delphinium menziesii*).—A somewhat hairy, tuberous-rooted perennial, about a foot high, with a basal cluster of

finely divided, long-stemmed leaves, and a single column of showy blue flowers, which appear at any time between April and July. This species is found native on hillsides from the vicinity of San Francisco to British Columbia and eastward as far as South Dakota. In Montana it is very common throughout the State. The percentage of fatal cases in cattle which have eaten this and other larkspurs is said to be small. A rough estimate by a cattleman places it at about 20 per cent for one species of the group, when the animals are not properly treated, and 5 per cent otherwise. This is probably a low estimate, however, for in a case of poisoning from *D. menziesii* that occurred in Montana in May, 1897, nearly 600 sheep were affected, 250 of which died. It is an excellent precaution to allow animals in pastures containing larkspur only when well fed, and then only for short periods, until they become thoroughly familiar with the deleterious nature of the plants.

Black Cherry (*Prunus serotina*).—Wild black cherry; wild cherry; rum cherry; whisky cherry. A valuable forest tree, 60 to 80 feet high. The fruit is rather agreeable, being but slightly bitter and astringent in taste. In some localities it is much used to flavor liquor. Poisoning is frequently caused in cattle by eating the wilted leaves from branches thrown carelessly within their reach or ignorantly offered as food. Children occasionally die from eating the kernels of the seed or from swallowing the fruit whole.

The prominent symptoms of black-cherry poisoning observed in cattle are labored breathing, diminished pulse, numbness, protruding eyeballs, convulsions, and death from paralysis of the lungs. In some cases there is considerable frothing at the mouth; in all there is a very perceptible odor of prussic acid in the breath. The freshly cut branches of the trees should in no case be thrown where cattle can get at them.

Woolly Loco Weed (*Astragalus mollissimus*).—Loco weed; crazy weed. A silvery-white, silky-leaved perennial 8 to 12 inches high, with an abundance of soft foliage springing out in a cluster from a short central stem close to the ground. The flowers are pea-shaped and usually purple. The pod is distinctly two-celled. This plant is native to the Great Plains region, extending from western Texas and New Mexico northward to South Dakota and Wyoming, being most abundant in Colorado and in the western part of Nebraska and Kansas. It grows both on the open prairie and on rocky hillsides. Horses, cattle, and sheep are affected by loco, but the principal damage is done to horses. The effect is not acute, but in its slow progress simulates diseases caused by bacteria and worms. Two stages are recognized. The first, which may last several months, is a period of hallucination or mania accompanied by defective eyesight, during which the animal may perform all sorts of antics. After acquiring a taste for the plant it refuses every other kind of food, and the second stage is ushered in. This is a lingering period of emaciation, characterized by sunken eyeballs, lusterless hair, and feeble movements. The animal dies as if from starvation, in periods ranging from a few months to one or two years. The damage done to

the live-stock business by this weed is immense. This genus contains a large number of species, and it is quite probable that many of these should be considered to be poisonous where they grow over wide areas of pasture land, and are green at periods when there is but little green grass. Over a half dozen have been reported to the Department of Agriculture as highly detrimental to the stock industry.

Stemless Loco Weed (*Aragallus lambertii*).—Loco weed; crazy weed; Colorado loco vetch. This differs from the true loco weed most conspicuously in its more erect and branchless habit, its longer leaflets, which are linear or oblong instead of ovate, and the one-celled seed pod. It ranges over the same territory as does the woolly loco weed, but extends farther, being found throughout the Great Plains from British America to Mexico, and it also ascends higher in the mountains, growing luxuriantly at Silver Cliff, in Colorado, at an altitude of about 8,000 feet.

So far as has been observed, the symptoms of poisoning are identical with those produced by the preceding species. The two plants are considered to be equally prejudicial to the stock-raising interests of New Mexico.

Rattlebox (*Crotalaria sagittalis*).—Rattleweed; wild pea. A hairy annual, 3 to 18 inches high, with simple undivided leaves, 1 to 2 inches long, and small, yellow, pea-like flowers appearing in July. The seed pods are about an inch in length when mature, and are nearly black. They are much inflated, and as the walls are stiff and thin and very resonant, they make excellent miniature rattles when the seeds have become detached from their fastenings inside the pod. The rattlebox is native in low, sandy soils from the Atlantic westward to Minnesota and eastern Kansas; also in New Mexico. It is common in Connecticut, New Jersey, and North Carolina, and in some years is very abundant in bottom lands along the valley of the Missouri, in South Dakota, and Iowa. The poisonous constituent is unknown, but it resides both in the leaves and in the seeds. Horses, and sometimes cattle, are killed by eating grass or meadow hay mixed with the plant. They are not poisoned so often by eating the plant in the field. Public attention was first called to the poisonous nature of rattlebox by Dr. Stalker, of Iowa, who in 1884, while investigating the cause of "bottom disease," then prevalent among horses in Iowa, was led to believe that it was mostly if not altogether attributable to this plant. Experiments were made which proved the supposition to be correct. As generally described from accidental cases, the symptoms are much prolonged, death resulting only after several weeks or months. There is a general decline of vigor and a gradual loss of flesh, as observed in the case of loco, with which this plant is closely related. The rattlebox does not, however, appear so often to produce the craziness characteristic of loco.

Caper Spurge (*Euphorbia lathyris*).—Garden spurge; myrtle spurge; mole plant; mole weed; mole tree; gopher plant; antigopher plant; wild caper; caper bush; wolf's milk; springwort. A smooth herbaceous, milky-juiced perennial, 2 to 3 feet high, with a stiff, erect stem, and opposite, four-ranked leaves, the lower of which are

thick and oblong, the upper thin, broad, and heart-shaped. The flowers are greenish-yellow and rather small. The three-seeded fruit is conspicuous. It is a common garden plant, sparingly introduced in wet ground in California and Texas, and in the Atlantic States from New Jersey to West Virginia and North Carolina.

The fresh milky juice is exceedingly acrid and the fruit is highly purgative and poisonous. When used as a household remedy it often provokes serious trouble. Women and children are not infrequently poisoned by handling the plant and getting the juice on the face. Cattle are quite resistant to its influence, but they are sometimes overcome. Goats will eat the plant extensively if nothing better presents itself, and it is said that their milk then possesses all of the venomous properties of the plant. When applied to the skin the juice causes redness, itching, pimples, and sometimes gangrene, the effect often lasting more than a week. The seed taken internally in overdose will inflame the mouth and stomach, and cause intense diarrhea and vomiting. If the dose is sufficient, there will be nervous disorders, unconsciousness, general collapse, and death.

Snow on the Mountain (*Euphorbia marginata*).—An annual plant 2 to 4 feet high, differing most conspicuously from the preceding species in its more slender and less branching habit, and in having its upper leaves broadly margined with white. Its general aspect is far more pleasing to the eye, and on that account it is more frequently gathered for decorative purposes. This spurge is a native weed of the Great Plains from Montana to Mexico, and is spreading eastward rapidly to Louisiana and through southern Minnesota and Missouri to Wisconsin, Illinois, and Indiana. It is cultivated considerably for ornament, especially in the Northern Atlantic States, where it has frequently escaped from cultivation. It has recently been introduced as a weed into Germany. The poison of this plant reaches the stomach so far as known only through the eating of honey derived from its flowers. Large quantities of fall honey are annually made unsalable in localities where the plant grows in great abundance. The honey is hot and disagreeable to the taste, but does not appear to be a very serious poison, its effects being confined mostly to vomiting and purging. The milky juice, when it gets on the skin, very often causes an itching inflammation, accompanied by pimples and blisters which last for several days. The general effect is much like that observed in rhus poisoning, for which it is sometimes mistaken. This blistering action is, in fact, so decided that a few stock raisers in Texas use the juice to brand cattle, it being held by them to be superior to a red-hot iron for that purpose, because the scar heals more satisfactorily.

Poison Ivy (*Rhus radicans*).—Poison oak; poison vine; three-leaved ivy; poison creeper; mercury or markry (N. H. and N. J.); black mercury (Me.); markweed (Me.); pickry (Me.).

A climbing or trailing shrub (sometimes erect), with variable three-foliate leaves, aerial rootlets, and greenish flowers, appearing in May and June. The smooth, waxy, white fruit often remains on the plant until late in winter. The leaves often resemble those

of the box elder. They differ from those of the Virginia creeper in having only three leaflets instead of five. Poison ivy grows everywhere in open brush, in ravines, and on the borders of woods, and it is spread along roadsides and cultivated fields from seeds carried by crows, woodpeckers, and other birds that feed upon its fruit in winter. Through ignorance or carelessness, and at the imminent risk of causing greatly bodily discomfort to many persons, this vine is sometimes planted about suburban and even city residence for the sake of ornament. It occurs wild in abundance throughout the United States as far west as eastern Texas, eastern Kansas, and Minnesota, and in greater or less abundance throughout the less arid region of the west, with the exception of California and the western parts of Oregon and Washington, where it appears to be entirely replaced by *Rhus diversiloba.* Recent experiments made by Dr. Franz Pfaff, of the Harvard University Medical School, have shown that the poison is a nonvolatile oil. It is found in all parts of the plant, even in the wood after long drying. Like all oils, it is insoluble in water, and can not therefore be washed off the skin with water alone. It is readily removed by alcohol, and very easily destroyed by an alcoholic solution of sugar of lead (lead acetate).

Numerous experiments show conclusively that the oil produces precisely the same effect as does the plant itself. When a very minute amount is placed upon the skin, it is gradually absorbed in the course of a day or so, and within certain limits the effect is proportional to the time of contact. In an experiment performed by the writer, the oil was applied to four places on the left wrist, and these were carefully guarded to prevent spreading. At the end of an hour one of the spots was thoroughly washed by successive applications of alcohol; in three hours the oil from a second was washed off in the same manner, and the others were cleansed three hours later. There was little or no effect on the first; that on the second was more marked, but did not equal that produced on the last two, which was about the same in each. The spots were within an inch of each other, but remained wholly distinct, a fact which very clearly shows that the affection is not spread by the blood. Subsequent applications of an alcoholic solution of sugar of lead gave speedy and permanent relief. In practice it is not desirable to use strong alcohol, which is apt to be too irritating to a sensitive surface, but a weaker grade of from 50 to 75 per cent is recommended. To this the powdered sugar of lead is to be added until no more will easily dissolve. The milky fluid should then be well rubbed into the affected skin, and the operation repeated several times during the course of a few days. The itching is at once relieved and the further spread of the eruption is checked.

Poison Oak (*Rhus diversiloba*).—Poison ivy; yeara; California poison sumac. The poison oak differs from the preceding species mainly in the character of its leaflets, which are somewhat thicker and smaller, more nearly elliptical, and less sharply lobed. Their similarity to the leaves of the Western oaks gives the plant its common name. The poison oak grows at low elevations in open

woods, on bushy hillsides and ravines, and sometimes along fences, in Arizona and to the west of the Sierra Nevada and Casade ranges in California, Oregon, and Washington. It does not, however, frequent the higher mountains.

This species produces about the same effect on the human skin as the poison ivy, and cases of poisoning are to be treated in the same way.

Poison Sumac (*Rhus vernix*).—Swamp sumac; dogwood (Mass.); poison dogwood; poison elder (Ala.); poison ash (Vt.); poison tree; poison wood; poison swamp sumac; thunderwood (Ga., Va.) A tree-like shrub 6 to 30 feet high, with long pinnate leaves having from 7 to 13 leaflets, without marginal teeth. The wood has a faint sulphurous odor, which, together with the leaf scars, which are very prominent, enables one to distinguish the plant from other shrubbery in winter. It grows in swamps and in damp woods from Florida to Canada and westward to Louisiana.

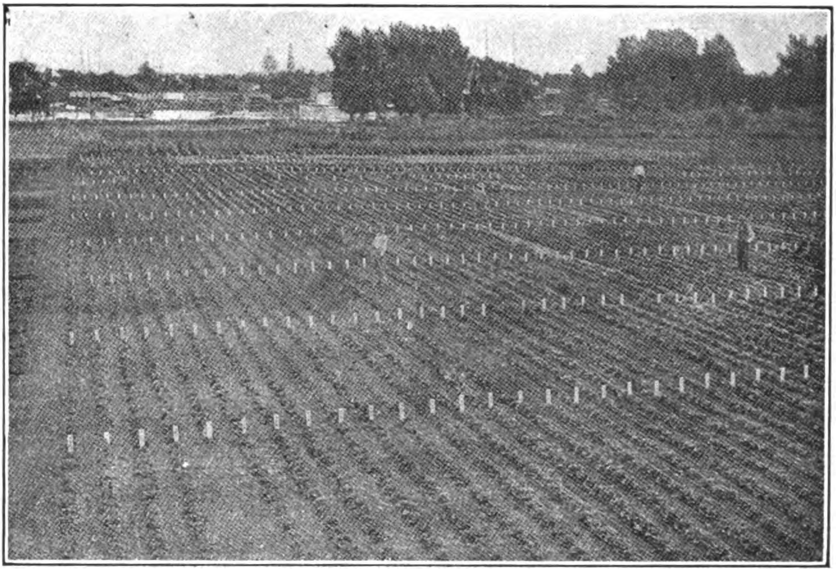
This also affects the skin in the same way as poison ivy, and cases require the same remedy.

Red Buckeye (*Aesculus pavia*).—Small buckeye; buckeye; horse-chestnut.

A shrub 8 to 12 feet high, with opposite long-stemmed leaves, and numerous clusters of bright red flowers, which appear in March. The fruit is smooth, even when young; the seeds are mahogany-colored and are elegantly polished. The red buckeye is native in fertile valleys from Virginia to Florida, throughout the Gulf States to Louisiana, and in Arkansas. It is sparingly represented in Missouri, Tennessee, Kentucky, and West Virginia. It is cultivated to some extent in Pennsylvania. The records of its poisonous action are mostly confined to its use as a means of procuring fish, but cattle are sometimes killed by eating the fruit. It was formerly, and perhaps is still, the practice to stir the bruised seeds or twigs into small ponds and gather the stupefied fish by hand as they rise to the surface. When thoroughly cooked these fish are quite wholesome.

The common horse-chestnut (*Aesculus hippocastanum*) is poisonous. In England, however, it is fed to cattle after the removal of the poison by thorough washing with alkali. Cases of poisoning by this and the next species have arisen from overdoses in medicine. The Ohio buckeye (*Aesculus glabra*) is regarded as intermediate between this and the above species in its poisonous qualities. The fruit of the California buckeye (*Aesculus californica*) is sometimes made into soup and bread by the Round Valley Indians, after removing the poison by roasting and leaching.

Water Hemlock (*Cicuta maculata*).—American water hemlock; wild hemlock; spotted hemlock; spotted parsley; snakeweed; beaver poison; musquash root; muskrat weed; cowbane; spotted cowbane; children's bane; death of man. A smooth, erect, perennial, 3 to 8 feet high, with a rigid, hollow stem, numerous branches, finely dissected leaves, white flowers, and a cluster of spindle-shaped roots, which vary in length from 1½ to 3 inches,



Vegetable Trial Grounds of the Office of Seed and Plant Introduction and Distribution on the Potomac Flats.

Bulb Trial Grounds of the Office of Seed and Plant Introduction and Distribution Showing Tulips and Hyacinths. Dept. of Agr.

and are very characteristic of the plant. It grows commonly in swamps and damp soil, throughout the Atlantic States, westward to Louisiana, Iowa, and Minnesota; much less commonly northwestward through Nebraska to the Rocky Mountains, and in New Mexico. This is one of the most poisonous native plants in the United States, being rapidly fatal to both man and animals. The roots are especially dangerous, because the taste being aromatic and to some people suggesting that of horse radish, parsnips, artichokes, or sweet cicely, is apt to lead children to eat them when they are found forced out of the soil by washing, freezing, or other causes in early spring. Cattle sometimes eat the tubers, and in marshes they are poisoned by drinking water contaminated by the juice of roots which have been crushed by being trampled upon. No estimate can be made of the amount of damage done to live stock, but it is very considerable. The human victims average several per annum. The prominent symptoms are vomiting, colicky pains, staggering, unconsciousness, and frightful convulsions, ending in death.

Oregon Water Hemlock (*Cicuta vagans*).—A smooth perennial, with erect or straggling glaucous stems 3 to 6 feet high, compound leaves, which spring directly from the ground, white flowers, blooming in July and August, and a fleshy root, which has a muskrat-like odor, and which consists of two very distinct and characteristic parts. The more conspicuous of these is the vertical rootstock, which is from 1 to 6 inches long by 1 or 2 thick, and is curiously divided into numerous chambers by horizontal partitions. This rootstock furnishes the bulk of the poison. The other portion of the root consists of solid, fleshy fibers, which run along on or just under the surface of the soil, and send off numerous rootlets from beneath. The rootstalk rots or dwindles away almost entirely before the seeds mature, but fresh ones are formed from it for the next season's growth. The plant grows in wet or marshy places, and ranges from British Columbia and Idaho southward to northeastern California, and perhaps to the southern Sierra Nevada. Cases of cattle poisoning have been reported from Victoria, British Columbia; Colby, Wash.; from various parts of Oregon, and from northern California. More than one hundred cattle it has been estimated are killed by it every year in Oregon. A piece of the winter rootstock the size of a walnut was found to be fatal to a cow. A piece the size of a marble is looked upon as dangerous to man. Human cases are not numerous, but a few have been reported in which individuals nibbled at the root through curiosity. When these plants occupy large areas, the only safeguard for cattle is to keep them on other pastures, especially when they are hungry. The plants may be destroyed by hand pulling when they occur in small quantities near dwellings or playgrounds.

Poison Hemlock (*Conium maculatum*).—Hemlock; wild hemlock; spotted parsley; stinkweed; herb bennet; poison root; poison snakeweed; cashes; wode-thistle. A smooth, purple-spotted, hollow-stemmed biennial, 2 to 7 feet high, with large parsley-like leaves and showy clusters of small white flowers, which appear in July and

August. The seed is prominently ridged, and has on its inner surface a deep, narrow, longitudinal groove. The fresh leaves have an extremely nauseating taste, and when bruised emit a characteristic mouse-like odor. Poison hemlock is native to Europe and Asia, but has become naturalized in the United States, and is rather common on waysides and in waste places in New York, West Virginia, Pennsylvania, New Jersey, and Ohio, and not rare in the New England States and in Michigan. It is infrequent in Wisconsin, Illinois, Louisiana, and California, but in some localities in the latter State it has a very rank growth. The characteristic poison of the hemlock is the well-known volatile, alkaloid conine, which is found in the seeds, and, especially at flowering time, in the leaves. The root is nearly harmless in March, April, and May, but is dangerous afterwards, especially during the first year of its growth. The poison hemlock is the most generally known poisonous plant historically, it being without much doubt the plant administered by the Greeks to Socrates and other state prisoners. Recent cases of poisoning have arisen accidentally from eating the seed for that of anise, the leaves for parsley, or the roots for parsnips; also from blowing whistles made from the hollow stems. It has recently been shown that some of the anise seed in both foreign and domestic markets is contaminated with hemlock seeds, but it is not known whether serious consequences have resulted therefrom. The symptoms in man are such as are due to a general and gradual weakening of muscular power. The power of sight is often lost, but the mind usually remains clear until death ensues, as it soon does from gradual paralysis of the lungs. The poisoning differs from that of the water hemlock (*Cicuta maculata*) in the absence of convulsions. Many domestic animals have been killed by eating the plant, the prominent symptoms described for cows being loss of appetite, salivation, bloating, much bodily pain, loss of muscular power, and rapid, feeble pulse.

Broad-leaf Laurel (*Kalmia latifolia*).—Laurel (north of Md.); ivy (south of Md.); mountain laurel; sheep laurel; poison laurel; wood laurel; small laurel; rose laurel; high laurel; American laurel; poison ivy; ivy bush; ivy wood; big ivy; calico bush; spoonwood; kalmia; wicky. A fine shrub, usually 4 to 8, but sometimes 30 to 40 feet high. It has thick, flat, and shining leaves, showy clusters of peculiarly shaped, viscid, and mostly inodorous pink flowers, which appear in May and June, and a globular, viscid, dry, inedible fruit. It grows abundantly on rocky hillsides, in cattle ranges, and on mountain slopes up to 3,000 or 4,000 feet, from Connecticut to eastern Ohio and along the Alleghenies to Georgia and Alabama; less abundantly in the New England and Southern States as far as Louisiana and Arkansas. Scores of cattle and sheep are poisoned annually by eating the shrub.

Narrow-leaf Laurel (*Kalmia angustifolia*).—Sheep laurel; lambkill; sheep poison; lamb laurel; dwarf sheep laurel; small laurel; low laurel; dwarf laurel; wicky. Like the preceding, but smaller, only 2 to 4 feet high, with smaller, thinner, and narrower

leaves, and smaller flowers, clustered, not at the extreme end of the stem, but at the base of the fresh shoots. It is abundant at low altitudes in both dry and wet soils from Maine to New Jersey; less abundant westward throughout the Great Lakes region and southward to Tennessee and South Carolina.

Great Laurel (*Rhododendron maximum*).—Laurel (south of Pa.); rosebay; mountain laurel; rhododendron; American rosebay; big laurel (Pa.); big-leaf laurel (Pa.); horse laurel (Pa.); deer tongue; cow plant (Vt.); spoon hutch (N. H.). A large evergreen bush or small tree, 10 to 20 or 30 feet high, with thick leaves, 4 to 10 inches long, and splendid clusters of large, inodorous, pale pink, or nearly white flowers, blossoming in July. A commonly cultivated ornamental tree, native to the Allegheny Mountains, but extending northward in isolated patches to Connecticut and New Hampshire.

Staggerbush (*Pieris mariana*).—Kill lamb. A weak-limbed deciduous shrub, 2 to 4 feet high, with thick, conspicuously veined leaves and showy clusters of tubular white flowers. It is frequent in low, damp soils near the coast from Connecticut to Florida.

Branch Ivy (*Leucothöe catesbaei*).—Hemlock; calf kill; leucothöe; dog laurel. An evergreen shrub, 2 to 4 feet high, with thick, tapering, sharply saw-edged leaves and numerous clusters of small, white, tubular, ill-smelling flowers, which appear in April or May. It grows abundantly, often forming dense thickets along stream banks in the Allegheny Mountains from West Virginia to northern Georgia.

Jimson Weed (*Datura stramonium*).—Jamestown weed; common stramonium; thorn apple; apple of Peru; devil's apple; mad apple; stinkwort; stinkweed (W. Va.); Jamestown lily (N. C.); white man's plant (by Indians). The jimson weeds are rank, ill-smelling plants, with large funnel-shaped flowers and prickly four-valved seed pods. They are mostly weeds which have been introduced into the United States from Europe and tropical America. The present species is a stout, smooth, bushy annual 2 to 5 feet high, with a coarse green stem, large flaccid leaves, and white, heavy-scented flowers 2 to 4 inches long. The flowers appear from May to September, and the fruit ripens from August to November, according to latitude. The seeds are numerous and about the size of a grain of buckwheat. When fresh they are ill-scented and nauseating, but later they are not so disagreeable. The nectar is sweet, but a little nauseating. It is found in most of the States East of the Mississippi, is common in eastern Kansas and Nebraska, in some parts of Colorado, and has obtained some foot-hold in all of the Western States. The purple-stemmed jimson weed (*Datura tatula*) is a somewhat taller plant, with purplish flowers and stems, but otherwise practically identical with the preceding, both in botanical and toxic characters. It is more abundant toward the South and West than the other. Cases of poisoning arise in adults from excessive use as a stimulant or as a medicine. Children are sometimes tempted to eat the fruit if they are permitted to play where the weed

is to be found. Several cases of this kind were reported. At Alpena, Mich., five children were badly poisoned by eating the seeds of the purple-flowered species, which was cultivated in a garden as a curiosity under the fanciful trade name of "Night-blooming Cactus." Several other cases where children have been poisoned by this plant have been reported. Children are also poisoned by sucking the flower or playing with it in the mouth. The fresh green leaves and also the root have occasionally been cooked by mistake for other wild edible plants. One or two instances are recorded in which cattle have been poisoned by eating the leaves of young plants which were present in grass hay. The symptoms of the poisoning are headache, vertigo, nausea, extreme thirst, dry, burning skin, and general nervous confusion, with dilated pupils, loss of sight and of voluntary motion, and sometimes mania, convulsions, and death. The jimson weeds should be removed from vacant lots by mowing the plants while in flower or by cultivating the soil.

Black Nightshade (*Solanum nigrum*).—Common nightshade; nightshade; deadly nightshade; garden nightshade. The black nightshade is a smooth annual, 1 to 2 feet high, with rough, angular, widely branching stems; ovate leaves, 2 to 4 inches long, with wavy margins; drooping clusters of small white flowers, and black, globose, juicy berries, which ripen from July to October. It is a common, introduced weed in rich shaded grounds and fields east of South Dakota and Arkansas, and in damp places westward to the Pacific Ocean. The amount of poison present in any part of this plant varies with the conditions of growth. The more musky-odored plants are the most poisonous. Nearly related to this plant is the spreading nightshade or "wild potato" (*Solanum triflorum* Nutt.), a native garden weed of the Great Plains region. It is a smooth, low annual, with widely branching stems, 7 to 9 lobed leaves, numerous clusters of small white flowers which are grouped in threes, and large green berries a half inch or more in diameter. These are not attractive to the eye, but have an agreeable odor and taste. The symptoms are about the same in man and animals. They are stupefaction, staggering, cramps, and sometimes convulsions. The pupil of the eye is generally dilated. Death is directly due to a paralysis of the lungs, but fortunately few cases are fatal.

Bittersweet (*Solanum dulcamara*).—Woody nightshade; nightshade vine; staff vine; fever twig; tetonwort. A climbing, woody, introduced perennial 3 to 6 or 8 feet high, with thin leaves, the lowermost of which are ovate or heart-shaped, the upper more or less spear-shaped. The flowers are purple, the fruit red. It ripens from July to October and November. The plant thrives best and is common along brooks and ditches from Massachusetts to Ohio, less common elsewhere in damp ground from Maine to North Carolina and to Wisconsin and Missouri. The berry, though its taste is not remarkably disagreeable, is somewhat poisonous, and it has been shown that an extract of the leaves is moderately so.

Sneezeweed (*Helenium autumnale*).—Sneezewort; autumn sneezwort; autumn sneezeweed; staggerweed (S. C.); swamp sun-

flower, false sunflower. A smooth, angular, branching perennial, 1 to 3 feet high, with rather thick lance-shaped leaves, and a large number of snowy yellow flowers which do not appear until autumn. It grows commonly in moist ground from Connecticut to Michigan and Illinois, and southward to the Gulf; less commonly northwestward from Louisiana to Oregon and Washington; also in Arizona. It has been found at an altitude of 6,000 feet in Nevada. The whole plant, especially the flower, is bitter and more or less acrid and pungent. The powdered plant causes violent sneezing when inhaled, and it is therefore used in medicine to produce that effect. Sheep, cattle, and horses that are unfamiliar with the plant are often poisoned by it when driven to localities where it abounds. As a rule, these animals avoid it, but it is claimed that they sometimes develop a taste for it and are killed by eating it in large quantity. The poison exists principally in the flowers. The young plants appear to be only very slightly dangerous; in the mature ones the amount of poison varies greatly even in the same field. The symptoms, as determined by experiments made in Mississippi upon calves, are an accelerated pulse, difficult breathing, staggering, and extreme sensitiveness to the touch. In fatal cases, death is preceded by spasms and convulsions.—(F. B. 86.)

Death Camas (*Zygadenus Venenosus*).—Wild lobelia, poison camas, poison grass, wild onion, poison sego, mystery grass, wild leek, crowfoot.

This is, in appearance, an onion-like plant, arising from a bulb and having narrow leaves and a single stem a foot or so high, with a narrow spike of yellowish white flowers blooming about June 1.

No part of the plant has the smell or taste of the onion and the plants appear singly scattered over the upland swales or valley slopes, where it is often found in the greatest profusion over extensive areas, which are white with its flowers during the period of blooming. It matures its fruit soon after blooming and early in July dies down to the ground again.

This plant is native from Assiniboia and Nebraska westward to the Pacific Coast and is found throughout the entire state of Montana (Mont. Bul. 45) and in every county of Colorado (Colo. Bul. 113). Apparently sheep alone are apt to be poisoned by this species. They first become stiff in the legs and have trouble in walking, later exhibit difficulty in breathing, stagger, foam at the mouth and nostrils with a jerking of the head and limbs in intermittent spasms, resulting finally in complete muscular paralysis and death.—(Mont. Bul. 45). See "weeds used in medicine," some of which are poisonous.

PROMISING ROOT CROPS FOR THE SOUTH.

Taro.—The taro (known botanically as *Caladium colocasia* or *Colocasia anti quorum*), which is so commonly grown for its edible roots in the Tropics, is more familiar to most persons in the United States in one of its garden forms, namely the large-leafed ornamental plant sometimes called "elephant's ears." There are many varieties of this plant, and it constitutes one of the most important starch-

yielding of foods of native races in southern China, India, the West Indies, etc. It has a rather disagreeable, acrid taste when raw, but this disappears on cooking. The root may be eaten boiled, baked, or cooked in other ways, and a sort of flour is also made from it. The native Hawaiians eat it in the form of poi—a sticky dough-like dish which is allowed to ferment before it is used. The composition of taro has been studied in connection with the nutrition investigations at the University of California. It does not differ very materially from potatoes in composition. Judged by a digestion experiment made in Japan, the carbohydrates of taro compare favorably in digestibility with those of other starchy roots, 95 per cent having been assimilated.—(F. B. 295.) Though among the oldest cultivated plants in the world, the fifty to one hundred varieties of taro now in cultivation have received very little scientific attention. Undoubtedly the larger number of these forms will be found to conform to the limitations of the species. For convenience in cultural discussions it may be divided into two groups, viz., the true taros and the dasheens. The petioles and blades of both groups are very similar. However, the tuberous offsets of the dasheens are seldom found among the true taros, although thickened, stolon-like, and more or less superficial offsets are common under certain circumstances in some of the taro types. The leaf is always peltate, though the angle which the blade forms with the petiole is variable; the comparative width of the blade and its irreglar marblings and mottled areas are also inconstant. Among the dasheens a bronze-purplish shading of petiole is a permanent feature, which, taken with its dwarf size and the tubers, renders the two groups readily separable. Among the taros color and markings run rampant; indeed, even the sap of two or three varieties is colored, or at least colors instantly upon exposure to the air. In Hawaii, where forty-five distinct varieties are recognized, the taros are roughly divided into upland and lowland sorts. Varieties of the latter type are usually flooded at frequent intervals during the growing season, partly to keep down weeds and partly because the plants require a great quantity of water. Although most taros contain from 15 to 25 per cent of starch, the size of the starch grain itself is so small and the gum content of the root is so high that it is doubtful whether any commercial method for extracting the starch from either the taro or the dasheen can readily be found. However, for grinding into flour or meal or for alcoholic distillation roots of both types of this section are eminently adapted. Two or three companies have already placed upon the market a flour made by grinding the cooked roots of some of the Hawaiian taros. Perhaps the commonest, or at least the most widely distributed, of all the taros is the common West Indian "eddo," or, as it is known in Porto Rico and Cuba, the "malanga." This variety attains a height of 3 to 5 feet, has comparatively few suckers, and produces in six to ten months a more or less cylindrical or fusiform rhizome from 6 to 12 inches long by 3 to 4 inches in diameter. The leafstalks are pale green, becoming almost white toward the base, although at the point of attachment with the rhizome there is fre-

quently a distinct shade of rose. The red or black taros are comparatively rare and until last year were practically unknown in the Western Hemisphere. The colors of the petiole vary from a pale reddish or maroon tinge to an almost black color. Of the latter type, the "kalukandala" of Ceylon may be taken as a type. This strong-growing and highly ornamental variety holds its nearly erect black petioles 4 to 6 feet high. The rhizome is yellowish inside, while its apex and the bases of the petiole are purplish. The culture of the taro occurs from the south-eastern United States (mainly in Florida) through the West Indies across the Pacific islands, Japan, China, the Malay region, Hindustan, Madagascar, and the whole breadth of tropical Africa. The natives of East Africa grow the taro extensively and have many named varieties.

Yautia.—The yautia, which is closely related to the taro botanically, though it belongs to a different group known as Xanthosoma, is a very important starchy food in the West Indies, where it is known by a variety of names, such as taniers or tannias, cocoes, eddoes, taye, etc. The cultivated varieties do not produce seed, though they occasionally put out abortive blossoms. The plants will thrive in almost any moist region free from frost and produce a large crop of roots in return for comparatively little cultivation. In Porto Rico every small farmer has his plat of yautias, and next to sweet potatoes and yams they are the most important native food crop. The flesh of the different varieties ranges in color from white to deep orange red. Both root stalks and the tubers which grow from them are edible, though the tubers are considered the more tender and of better flavor.—(F. B. 295). The yautias, or, as some varieties are called in the British West Indies, taniers, are perhaps more important from the commercial point of view than either the taros or the dasheens. These three types of plants occur throughout the world in from 100 to 200 varieties. The general aspect of the plants belonging to this group is that of the so-called caladium, or elephant-ear, which has become popular as an ornamental during the two or three decades. They are succulent, stemless plants, although some varieties produce a rhizome, or main rootstock, 2, or even 4, feet in length, the greater portion of which may be above the surface of the ground. The leaves arise from the tip of this rootstock or from its offsets or tubers. The leaf stem ranges from 1 to 8 feet in height; it is usually grooved near the middle, forming a sinus which at its lowest extremity is wrapped about the tip of the root stock. Most varieties seldom or never produce flowers, and none of the cultivated forms have been observed by the author to produce seed under any circumstances. In fact, the yautias are considered the oldest cultivated crop in the world—and probably the only one, with the exception of the highly cultivated taros—which does not ripen seed under favorable conditions. The entire plant of both the taro and the yautia is filled with laticiferous ducts containing a yellowish juice, which upon exposure rapidly thickens and turns brownish, forming a viscid gum. The true sap indelibly stains white cloth a reddish brown. No record of the yautia as a crop in

southern South America has been obtained. So far as known the first specimens of yautia to reach Asia (Singapore) or Australia (Ipswich, Queensland) were distributed by this station. And it appears that, although more readily propagated, more productive, and fully as palatable as the taros, which probably originated in the same region, the yautia has unaccountably remained exclusively a tropical American plant. The usual method of harvesting yautia is by hand pulling, supplemented by the use of the hoe. In loose soil one man can gather the tubers from 5 to 10 plants per minute; that is, 1,000 to 2,000 pounds of tubers per hour. The leaves are usually left attached to the root for some days after harvesting; then they are cut off about 4 to 8 inches above the top of the old root, which is thrown into a pile to await planting time, or if for market the fine roots are trimmed off and merely the tip is reserved for the seed pile, while the edible portion is sold along with the tubers. While single plants may yield as high as 6 or more pounds of tubers, the average for common varieties in ordinary soil may be reckoned at 2 to 3 pounds per hill. With 10,000 plants per acre this gives 10 to 15 tons of roots per acre. To this may be added 5 to 8 tons of the "madres," which in several varieties are sold for table use and which may be utilized as a source of starch or for fattening swine and poultry.

Composition.—Analyses of two samples of yautia have been made at the Maine Experiment Station, and the results given below are quoted from unpublished material. A white variety contained 85.9 per cent edible portion and 14.1 per cent refuse, i. e., parings. A yellow variety contained 76.9 per cent edible portion and 23.1 per cent refuse. In the preparation of ordinary Irish potatoes and sweet potatoes for the table, the edible portion constitutes on an average 80 per cent and the parings or refuse 20 per cent of the tuber. The following table shows the composition of the two varieties of yautia analyzed, calculated to a uniform basis of 70 per cent of moisture, and includes for purposes of comparison the composition of Irish potatoes and sweet potatoes:

Yautia and potato	Water.	Protein.	Fat.	Total carbohydrates. Sugar, starch, etc.	Total carbohydrates. Crude fiber	Ash.	Fuel value per pound.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
White yautia	70.0	1.7	0.2	26.3	0.6	1.2	529
Yellow yautia	70.0	2.5	.2	26.1	.6	.6	538
Irish potato	78.3	2.2	.1	18.0	.4	1.0	385
Sweet potato	69.0	1.8	.7	26.1	1.3	1.1	570

The analyses show that yautias do not differ materially in composition from the potatoes. As is the case with potatoes, carbohydrates constitute the chief nutritive material. An examination of the yautias shows that the principal carbohydrates present is starch.

Summary.—The planting of yautias, taros, and dasheens should be begun as soon as the danger from frost is over, for they require six months or more to mature. It is native to tropical America and

is scarcely known outside of this district. The tuberous offsets of the rootstock are the principal edible portion of the plant, though the leaves and, in nearly all varieties, the rhizomes are eaten. The tubes are used like potatoes; the leaves are boiled and eaten like spinach. The crop is grown preferably in moist soil; a great variety of soils may be utilized, however, and 6,000 to 12,000 plants per acre may be set, according to the variety. The yield per acre is from 7 to 15 tons in ordinary soil. The "head," or top of the rootstalk, is preferred for planting; the tubers or any part of the rhizome system possessing "eyes" may be used. Tubers may be left in the ground in the dry season for six to twelve weeks after ripening. Harvesting is usually done in the dry season, from December to May. Tubers keep well if kept dry after digging. The crop has no serious fungus nor insect pest. Its introduction into the frostless region of the United States is possible. The fresh tubers may be shipped to the Eastern and Central States. Fresh tubers yield about 30 per cent of flour; this may be shipped to any point. The cost of raw material to produce 1 pound of flour is about 2 cents.—(B. P. I., B. 164; Porto Rico B. 6.)

Yams.—In January, 1899, collections of yams (*Dioscorea* spp.) were imported by the United States Department of Agriculture from Jamaica and Barbados, British West Indies, for distribution mainly in Florida, where they have been tried by a number of experimenters. Several varieties of yams are already cultivated in the South, but not so many nor so good as those grown in the West Indies. The cultivation of this crop is not, as might be supposed, confined to the negroes, but is given serious attention by some of the most intelligent planters in Jamaica. It is especially adapted to the higher portions of the island. Many of the coffee planters grow it for their own use and for sale to the less thrifty negroes. The profits from its cultivation are not great, but it is reasonably remunerative. The consular reports do not show that there is any commercial importation of yams into the United States, but a market could undoubtedly be created for the best varieties, as it is a vegetable of sufficiently characteristic flavor to win a place for itself on the best hotel tables. The variety which is superior to all others is the "yampie." This is worthy of serious consideration by the Florida truck farmers and by the Louisiana planters as a vegetable to be grown for the highest priced or fancy markets. A baked yampie is more palatable than a baked potato, and the crisp skin has a flavor different from that of any other vegetable.

The West Indian yam is not a crop that will supplant the sweet potato, but the different varieties will form a welcome addition to subtropical agriculture in the United States and in the new insular dependencies. The finer varieties, possessing as they do a characteristic flavor, will undoubtedly fill an important place in the northern markets.—(Div. B. Dept. Agr. Cir. 21.) There are, as said before, many varieties of yams, different species cultivated in different parts of tropical and sub-tropical countries. The cultivated yam, with its large tuberous roots, resembling the sweet potato, though not so regu-

larly formed, produces a slender twining and high climbing vine. The root contains a large amount of starch, sometimes 25 per cent and hence is highly nutritious and in tropical lands largely takes the place of the potato. However people of Caucasian extraction do not relish it so well. It lacks the mealiness of the potato. The yam was planted at the Louisiana Experiment Station on poor land in rows six feet apart, and six feet apart in the row. It was fertilized with a small amount of stable manure and acid phosphate, and given a low trellis to cling to.

It grows in rampant fashion, the vines being from ten to twenty feet in length. The season of freedom from frost here does not seem to be long enough for it to form any aerial tubers in the axils of the leaves, as only a few have appeared in the axils of lower leaves. These aerial tubers are used for seed. It is probable that the plant could be rapidly propagated by cuttings of the vine, as these have a strong tendency to root at the joints, wherever the vine rests on the ground.

A growth of one season gives yams as heavy as two pounds. When broken these yams are very mucilaginous. Boiled like potatoes they are very palatable and wholesome food. They keep in the ground from year to year without becoming woody, and constantly increase in size. A small patch of them grown in the garden would yield every day in the year an excellent food for the table, by digging as wanted. Taking the yam does not injure the growth of the remainder of the plant, if the roots are not much disturbed. Many old Floridans in all parts of the State now grow yams for family use. Newcomers may find it profitable to cultivate a patch for this purpose. They are excellent food for all kinds of stock, but possibly it would not be profitable to cultivate them for this purpose only, as there are other crops which might give larger returns.—(Fla. B. 35.)

Golden Seal.—As in the case of many other native medicinal plants, the early settlers learned of the virtues of golden seal through the American Indians, who used the root as a medicine and the yellow juice as a stain for their faces and a dye for their clothing.

This medicinal plant was formerly plentiful in high open woods from southern New York to Minnesota and western Ontario south to Georgia and Missouri, ascending to an altitude of 2,500 feet in Virginia. It is now becoming scarce and since it is commercially quite valuable, bringing a minimum price of $2 per pound, and being readily sought at home as well as abroad, the plant is now being cultivated with success. The cultivation of golden seal is simple. There are three ways of propagation: (1) by seed, (2) by division of rhizomes, and (3) by means of budding the roots. Artificial shade, imitating that of the woods, should be provided. The root should be collected in autumn after the plants have matured seed. After the roots are removed from the earth they should be carefully freed from soil and all foreign particles. They should then be sorted, and small, undeveloped roots and broken pieces may be laid aside for replanting. After the roots have been cleaned and sorted they are ready to be dried or cured. The

yield obtained by the Department from small plats has been at the rate of 5,000 to 6,000 pounds of green roots per acre, which on drying was reduced to 30 per cent, making about 1,500 pounds per acre. The yield from small plats can not be calculated as accurately as from larger areas, but these figures constitute a good basis for a conservative estimate.—(B. P. I. B. 51.)

Camphor Cultivation in the United States.—The camphor tree seems to be native in the coastal regions of Southeastern Asia. The tree or shrub, it being used as a hedge-making plant, was brought to America about 50 years ago, in the form of seedlings and planted in Florida, whence, during the past dozen years, camphor trees have been very extensively planted for ornament and as windbreaks in the Southern and Southwestern States and in some places nearly every home has one or more camphor trees in its yard. One Florida nursery alone sells annually about 15,000 trees. Camphor, the well known drug used as a nerve stimulant in various ways and for divers other purposes, is distilled from the body of the tree, the twigs and the leaves; mainly from leaves and twigs obtained by trimming growing trees, shrubs or hedges, where the species is being cultivated. In most places in the South the tree has two growing seasons and two dormant periods. Growth begins in February and before May 1 a leafy growth of 6 to 10 inches has formed. On this growth are formed the flowers and seed. From May 1 to June 15 the weather is hot and dry and the tree goes into a dormant period. With the coming of the summer rains growth begins again and continues until about the middle of September, when the winter dormant period begins. Camphor can be propagated by seed, cuttings, and root cuttings. The seeds will begin to come up about three months after planting, but four or five months are often required for a full stand. The first season the plants should make a growth of 12 to 18 inches, with a very large and vigorous root system. The treatment the second year should be the same, and at 26 months from planting the plants should be from 2 to 3 feet high and well branched. At this time they are ready for field setting. Up to the present time nearly all camphor is made from the wood of old forest trees and but little use has been made of the leaves and branches. This is partly due to the fact that in the camphor countries the camphor is localized mostly in the old wood, while that in the leaves contains a large percentage of oil. In the Southern States the camphor yield of the leaves is high and there is little in the wood before it reaches an age of 10 years or more.—(Dept. Y. B. 1910.)

Cacao.—The culture of the cacao tree, from the seeds of which chocolate is made, was an important industry among the natives of Guatemala and southern Mexico before the advent of Europeans. This food beverage has been found very acceptable, and from that time to the present there has been a gradual increase of popularity with no present indications of a limit being reached, unless through popular disgust with extensive adulteration. Thus, although the culture of cacao is an old industry, it is still one of the most promis-

ing branches of tropical agriculture. In the way of caution, it may be noted that while cacao was formerly, and may again be made, of some agricultural importance in Porto Rico, the growing of cacao as the only resource of the planter can not be advised, since this crop is especially liable to loss through hurricanes, owing to the fact that the large fruits are borne on very slender stems, which rise directly from the old wood, and are thus very easily broken off and destroyed. The Philippines, where cacao has long been cultivated, should be the better field, not only because of the larger extent of probably suitable land, but also because the relatively high value of cacao renders the cost of shipment proportionally much less than with sugar and other cheaper and more bulky products.—(Y. B. 1901.) Cacao plantations have been established at Hilo, Hawaii, with apparent success.—(B. 170 B. P. I.) Cacao has received special study. The cultivation of this crop is confined almost entirely to humid localities, in accordance with the belief that such a climate is necessary to the welfare of the tree. This belief is erroneous, and it is expected that with better cultural methods the growing of this important crop will become an established industry in all the tropical possessions of the United States. Millions of dollars are paid annually by this country for tropical products grown outside of our territory. The efforts of the Department have been in the direction of encouraging the production of these crops, as already indicated, in tropical dependencies.—(Y. B. 1905.)

*Prickly Pear as a Farm Crop.**—No attempts have hitherto been made to cultivate prickly pear as a regular crop in this country. The nearest approach to it was made by some of the old mission fathers of California, who imported cuttings, probably from Mexico, and planted them in hedges, where they served the double purpose of barriers against stock and as food for man. That they received any appreciable degree of cultivation, however, is very doubtful. They were probably grown in much the same manner that the so-called cultivated prickly pears are grown in Mexico to-day. An extended use has been made of the native crop at various times for the past fifty years or more in southern Texas, but it has mainly been spasmodic, lasting only until "the drought was broken," except for sheep and goats, which are fed on it regularly, and in the case of the few dairymen who have made it a practice to feed it for a portion of each year. There was little expectation that the plants would respond to cultivation as they have done. It has proved itself under cultivation not only an emergency feed but an insurance against famine, as well as a plant which can be grown and depended upon regularly as a farm crop. There are many points connected with the various operations of planting, cultivating, and handling of these plants that have not been fully demonstrated as yet. The best that can be done in connection with some of these processes is to give an account of the methods which have been used in these experiments. It is expected, of course, that these will be improved upon as experience in growing prickly pear becomes more extensive. The main hay crop upon the ranch where the experiments

* For illustration, see page 503.

conducted has always been sorghum, and since the experiments were started this has been placed in a silo. In the season of 1906 about 1 ton of silage was secured to the acre, and in 1907 about 2½ tons. These are estimates made in the silo.

In feeding tests upon the ranch in 1905 it was found that 6 pounds of prickly pear produced the same results in feeding dairy cattle as 1 pound of dry sorghum hay. If 1 ton of hay is assumed to be equivalent in feeding value to 3 tons of silage, then the hay production from sorghum has been on an average for the two years only seven-twelfths of a ton to the acre per annum. This seven-twelfths of a ton of hay, assuming the relative value of sorghum hay to prickly pear to be as 6 to 1, is equivalent to only 3½ tons of pear. In other words, prickly pear has produced more than six times as much roughage during the two years as sorghum. Of course, the yield of sorghum mentioned was abnormally small, but, seasons occur every now and then in this region when crops are short, and while they may be assumed to be at the lowest point of production during these two years it is against these years of shortage that it is necessary to provide. The plants are most advantageously grown from single-joint cuttings, which are easily prepared cutting up all of a full-grown plant into single joints. Plants should be established about 2 feet apart in 6-foot rows. When the ground is moist and well prepared, cuttings can be distributed on the surface of the ground. When these conditions are not met the cuttings should be placed in a furrow and partially covered with another furrow. Planting may be done at any time of the year, except during the hottest and driest part of summer. Cultivation should be shallow and sufficiently frequent to keep down the weeds. Plants set in February may be harvested at any time after 24 months.

It is believed that it will be found advantageous in harvesting to singe the spines of the standing plants and then cut them down to be grazed. However, good results have been obtained without cutting. It is possible to singe after cutting, but it is a little more difficult and will probably be attended with more waste. It will be advantageous in harvesting to leave a stump of two to four joints rather than to harvest too closely.

Those forms which are most vigorous and most free from disease should be selected for stock to plant. In the vicinity of San Antonio, Texas, this is the typical form of *Opuntia lindheimeri*. With good labor and proper management this expense, it is believed, the cost of planting will not exceed $6 or $7 an acre. Even $9 per acre is low for a plantation that does not require renewing for fifteen or twenty years. The spineless forms thus far grown (about twenty varieties) are practically useless under present conditions in Texas except for breeding purposes. A conservative estimate of the annual production of prickly pear under cultivation is 22 4-5 tons, or enough roughage for one bovine animal for a year from each acre of ground. This is to be harvested biennially. Cattle, sheep, goats, swine, and even chickens will eat the crop readily at

any time of the year. Eight times as much growth of prickly pear has been secured under cultivation as was obtained without cultivation in ungrazed pastures. More than six times as much roughage (actual feeding value) has been secured from prickly pears as from sorghum. One fungous and one insect enemy of prickly pear of some importance are found, both of which may be controlled either by selection of stock or by methods of harvesting, or by both combined. The diseased condition known as dropping of joints is believed to be purely climatical. This, while costing a month's growth in the spring, is not looked upon with any apprehension.—(B. P. I. B. 124.)

The Tuna as Food for Man.—The prickly pear of the American and the Australian, the Indian fig of the Englishman, the Barbary fig of the Frenchman, the tuna of the Spanish-American, and the higos chumbos of the Spaniard is a fruit concerning which there are more varied beliefs, contradictory opinions, and grades of appreciation than any other known to us. The plant and its fruit are subjected to both praise and abuse. While the Mexican prays that there may be no rain when the plants are in bloom, in order that the fruit may set well and produce a good crop of tunas, Australians pass laws for their eradication. Less than 20 years ago stockmen in Texas desired the eradication of the prickly pear; now they consider it a valuable stock food while, especially along the border line of Mexico from southwestern Texas through New Mexico to southeastern California, they are not only considered good food for stock but also for man. The tuna, which is the fruit of the prickly pear and sprouts out of the parent plant in great numbers, almost as do the Brussels sprouts along the stems of the old plant, though, of course, different in form and composition, are greedily sought in the vegetable and fruit markets of the region referred to. During the height of the season, when the fruit is cheapest, women appear on the markets each morning with huge baskets of them ready peeled, which they place in earthen saucers, and dispose of for one cent each. Each purchaser is furnished with a tip of maguey leaf or a thorn of the mesquite with which to eat the pulps, or, in a few instances, modern wooden toothpicks are served with them.—(B. P. I., B. 116; N. Mex. B. 64.)

Australian Wattle.—The bark of the Australian black wattle tree has long been in use for tanning purposes. It does not give the leather as fine a bloom as the bark of the American oaks or the acorn cups of the valonio oak, but it tans more quickly and is in good demand for the common grades of leather. It had been demonstrated that wattle grew well upon the hillsides of said country and that the bark brought a price as high as $82.79 per ton, and hence it was not difficult to convince people that the experiment of its culture was worth making. An acre of 10 year old wattles will furnish 5 or 6 tons of bark. This was extensively done in Natal, South Africa, with success.

Although there may be some reproduction by sprouts from the stumps of the felled trees, these sprouts are not counted on as im-

portant in the re-formation of the forest. In fifteen months these somewhat irregular rows of trees are 18 feet high and in four years from the time that the old forest is cut down, these rows of seedlings will have grown to such a height that they will require thinning out, and among the trees cut out in this process there are many which yield a fair quantity of bark.

An industry which pays so well in the new country of Natal, and does not require a large amount of hand labor, sixty men being sufficient for 2,400 acres, is worthy of the attention of American cultivators. The climatic conditions seem favorable in Hawaii, and doubtless also in some of the American island possessions, but whether they are as favorable as they are in Natal, where it is claimed that the species grows more luxuriantly than in its native land, may be a question.—(B. P. I., B. 51.)

Sumac.—There are various varieties of this shrub. The *rhus copallina* or dwarf sumac grows almost anywhere, throughout the eastern half of the United States, in the north as a mere shrub and southward as a small tree. The California sumac (*rhus laurina*) prevails in the Pacific Coast States. In the Atlantic States is found the *rhus venenata,* variously called poison sumac, swamp-dogwood, poison elder and poison ash. The effects brought about by coming in contact with this poisonous species are rather worse than that caused by poison ivy. The nonpoisonous varieties are sometimes used as ornamental shrubbery, the foliage producing a marked and pleasing effect during the late summer and fall. Bobwhite (quail and partridge) are very fond of the bright carmine berries of the sumac and may generally be expected to be found where the plant is not scarce. Another variety, the Sicilian sumac (*masculino*) is very much sought as a tanning material for pale colors and soft tannage, especially for moroccos, roans, shiners, etc., and for brightening the color of leather tanned with dark materials, and from 12,000,000 to 18,000,000 pounds of that special variety are imported for that purpose from Italy annually. This Italian product comes generally very much adulterated, so much so, that it has become a question worthy of being inquired into, whether the American sumac could not be used instead, at a much smaller cost at that. When high-grade, light-colored leathers or durable sumac-tanned leathers are required, as for instance in bookbinding, adulteration results in discoloration and destruction of the leather in a much shorter time than when pure sumac is employed in tanning, and the money loss thus occasioned is many times the difference in cost between a pure and an adulterated sumac.—(B. P. I., B. 117; Y. B. 1902, 1905.)

Bamboo.—The growing scarcity of wood for manufacturing purposes and the unusual and important uses to which the bamboo is put by the people in the Orient has led the Bureau to make some extensive investigations of bamboo culture in Japan and other countries. Already a number of varieties have been introduced and steps have just been taken for the inauguration of a considerable number of plantations of these important plants in different

parts of the South. The discovery by means of various importations that this useful plant can be grown along the Gulf States and in California has induced the Bureau to engage an expert in Japan, who has made purchases of several thousand bamboo plants, which he has now shipped to this country. These form the nuclei of small plantations established in the Southwest, where the climate is suited for the crop. If it is found that the bamboo may be successfully grown on these plantations its cultivation will be extended, with a view to getting the wood introduced into various channels of trade here.—(Y. B. 1908.)

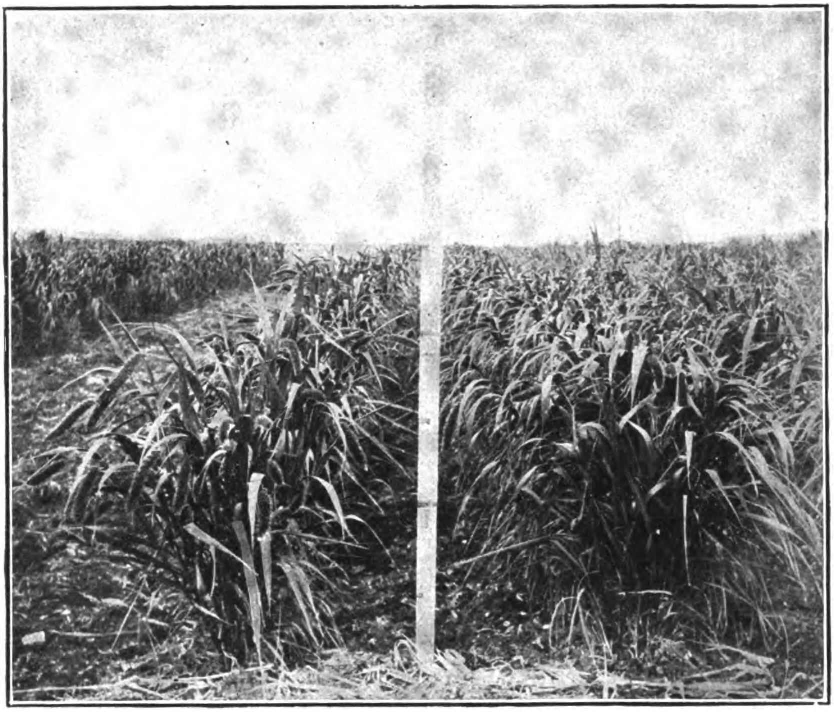
Ten acres of Japanese timber bamboo are now growing at Brooksville, Fla., as a result of the introduction of more than 3,000 young plants from Japan, while a similar but smaller area is located at Avery Island, La. This is the first serious attempt in this country to test on a commercial scale the culture of a plant which in the Orient forms one of the best paying crops.—(Y. B. 1910.)

It is, of course, generally known that a native variety of bamboo called cane is found forming the so-called canebreaks in Mississippi, Louisiana and in other parts of the southeastern States. That variety does, however, not grow any larger than the fishing poles on sale anywhere.

*Roselle.**—Fruits and economic plants indigenous to the Tropics are now as never before attracting the attention of the people of the United States. Some, such as the avocado and the guava, are natives of the Western Hemisphere; others, like the roselle, are introductions from the Old World. A strictly tropical plant, the roselle is very sensitive to frosts. This, together with its peculiar habit of blooming late in October regardless of the time when the seed is planted, has restricted the cultivation of the roselle to tropical and subtropical regions. Its distribution, for this reason, has not been so general nor has the plant become so widely known as introduced plants indigenous to the Temperate Zone. Introduced several years ago into California and Florida, the roselle deserves a wider cultivation than it now enjoys and should prove a valuable acquisition to the tropical islands of the United States and to the Canal Zone. The cultivation of the roselle is so simple and its requirements so few that in the Tropics and Subtropics it should be an indispensable plant in the garden of every family, and on account of its excellent qualities for making jellies, jams, etc., it is certain to become an important plant in the manufacture of those products. The young stems also make good jelly. For such use the plant can be grown almost anywhere in the North or South. By proper methods of breeding it is possible to obtain strains with larger calyces. Probably earlier bearing races can also be obtained by careful selection of the earliest flowering plants. The roselle is subject to only one disease, a mildew which does considerable damage to the plant, while the soft scale, the cotton stainer and yellow aphis attack the plant, but remedies against all of these seem to be easily obtained.—(F. B. 307.)

Rubber.—The whole tropical world is entering into the culti-

* For illustration, see page 159.



MILLET IN ROWS AT THE EXPERIMENT FARM, BELLEFOURCHE, SOUTH DAKOTA.

(See pages 110–116)

MESA IN NEW MEXICO: GRAMA GRASS.

(See pages 121-122, 164.)

vation of rubber on a wholesale scale. Rubber is practically the only staple crop the supply of which has always come from what may be called natural sources. Even with the increase in the number of plantations during the last ten years 99 per cent of all of the rubber of commerce has been procured by the most wasteful and destructive methods from natural rubber forests. The rubber gatherer has preceded the tax collector in searching the unexplored and unknown forests in the interior of South America and all over the African Continent. He has destroyed forests and exterminated species in a relentless effort to secure enormous returns without the investment of proportionate capital. Wherever the rubber collector has gone no other need follow.

The cause of this frantic search for rubber-producing trees is to be found in the multitudinous uses to which this valuable material may be put. Because of its increasing scope of usefulness the rubber consumers have never been able to procure enough of the raw material to satisfy the yearly demands, so that the end of every decade has witnessed a marked increase in its value.

By January, 1908, 400,000 rubber trees had been planted in Hawaii, upwards of 90 per cent being *Manihot glaziovii*. The remainder are *Castilloa elastica* and *Hevea brasiliensis* in about equal proportions. There are now five large plantations in operation, and rubber trees are being planted by many independent farmers and planters. The oldest plantation is one of those at Nahiku. A first tapping was made on some of the trees of this plantation during the summer of 1908. Tappings begin when the trees have reached a circumference of 20 inches, which is considered to be the smallest size at which it is safe or convenient to tap.

The natural home of the Ceara rubber tree (*Manihot glaaziovii*) is in the dry regions of Brazil. In former years it was very abundant in the State of Ceara and derives its name from this fact. It is also known as the Manicoba rubber, this having been its native name.

This tree is closely related to the cassava (*Manihot utilissima*). It belongs to the spurge family, which also includes the Para rubber (*Hevea brasiliensis*) and many other rubber-producing plants. Most of the members of this group, the *Euphorbiaceæ,* have milky sap.—(Hawaii Sta. B. 16.)

Guava.—The guava (*Psidium guajava*) is most peculiar in that when ripe its odor is usually very offensive to the uninitiated, but after a considerable familiarity with it the odor is no longer disagreeable and most people like it. Not a few, especially those who are familiar with a variety of odors, consider it pleasant from the first.

Commercially, the guava is the leader of the jelly fruits. The fact, however, that it decays soon after ripening makes it impossible to keep it on the market, as is done with ordinary fruits. Jelly factories have to be established near the place where the fruit is grown, but with good railway service guavas may be transported 300 miles without danger of loss. For immediate home use large

quantities are sent annually by express to all portions of the United States south of the Ohio River and also to New York.

No extensive guava orchards have been planted, as the market has been somewhat uncertain. During the height of the season the jelly factories usually take all the fruit offered them at 75 cents to $1 a bushel. These prices are remunerative, since the fruit is merely shaken from the trees, picked up, and delivered. For shipping purposes the uniform charge for the fruit is $1 a crate. In the southern extremity of Florida, in addition to the regular crop, there are guavas ripening throughout the entire year. These find ready sale in the local markets at good prices.

The fact that the ripe fruit does not remain in good condition for more than three or four days makes it also imperative that it be sent only to customers who order it in advance. These people find it the cheapest jelly fruit in the market, in spite of the fact that the express charges are from $1 to $1.50 a crate. Even at a cost of $2.50 to $3 a crate delivered, it is considered the cheapest jelly fruit obtainable.—(Y. B. 1905.)

The guava is no longer cultivated in the islands. It was early introduced, and finding a congenial soil and climate has grown wild and has spread over the islands, forming dense thickets. It bears fruit in great abundance (Pl. XIII, fig. 2), which falling and decaying upon the lava soils, assist largely by their acid properties in disintegrating them. There is here a fine field for the manufacture of guava jelly on a large scale, thousands of tons of the fruit wasting every year. Locally some of the progressive housekeepers make annually a few jars of this jelly, which is of excellent flavor and attractive color. *P. cattleyanum,* the cattleya or Chinese guava, is cultivated to a limited extent.—(Hawaii B. 95, 1901.)

Cocoanut.—About thirty years ago a consignment of cocoanuts was received from Central America, and some years later a small quantity was procured from the West Indies. These were distributed in localities where it was supposed the plants would flourish. At that time but little was thought about the profitable culture of the plant, and it is presumed that no attention was given to the few sent out by the Department. Of late years, however, more attention has been given to this fruit in southern Florida.

The cocoa palm is certainly the most characteristic object of the Tropics, and its beauty is equaled only by its utility among Tropical peoples. In commerce it appears in three forms. The fresh nuts are shipped to Europe and America for eating or for use in desserts and confectionery; the dried meat is marketed under the name of copra for the extraction of the oil, and the fibers of the husk are sold as coir, and used in the manufacture of brushes and coarse fabrics. Although the cocoa palm exists in large numbers in Porto Rico, few nuts are exported and no copra or coir is made. Nearly all the nuts are picked while still green, and are bought in the cities and towns for the sake of the milk, which is the most popular beverage of Porto Rico. Copra and coir come largely

from the Pacific islands and the East Indies, and both are prepared by natives in their leisure time, though machines and improved processes for extracting the fiber have been invented.

There is much confusion between the words "cocoa," the name of the palm that produces the cocoanut, and "cacoa," the plant that produces the chocolate, so much so that even public documents may be found wherein it would appear that chocolate is a product produced by the same palm that produces the cocoanut, which is not the case.—(Y. B. 1901, 1902, 1907.)

The Drug Dioscorea Villosa.—Common names, Yam root, China root. This plant is a twining and climbing vine, resembling in some respects the morning-glory. The root is of a most singular tortuous form, of a woody consistence, with numerous spiny protuberances. It is perennial, and doubtless endures a greater number of years than the roots of most plants of similar habits. The sprangles are usually near half an inch in thickness, and the whole root in favorable situations is often found to weigh half a pound. The stem is a climbing annual vine, winding around small shrubs, and insinuating itself among brambles, often attaining the height of 6 or 8 feet. Near the ground the leaves usually appear in verticillate clusters, or whorls, varying in number from two to eight or more in a bunch, dependent on the luxuriance of the soil. Higher up the leaves are alternate. They are always on pretty long footstalks and of the form of a heart, with the point acute and turned to one side; commonly roundish as well as cordate and nearly 2 inches across. Almost always you may count just nine nerves or portions of framework, proceeding from the base toward the apex. The flowers show themselves in May and June; they are very small and white, arranged on little stems which come out just above the leaves. The seeds are triangular, similar to buckwheat, though four times as large, with wings at the angles. The yam root grows plentifully in the Western States, delighting in fertile hillsides, thickets, and open woods.

An infusion of the root is a valuable remedy in bilious colic. The rhizoma of *Dioscorea villosa* is a favorite therapeutical agent among eclectic physicians, who have advantageously used it for more than forty years. It is known as wild yam and colic root. The first specimens employed were from the *Dioscorea villosa,* with pubescent leaves, now known as the "true wild yam." About the year 1850 botanic druggists noticed the admixture by root diggers of the rhizomata, and for a considerable time rejected it as an adulteration. The diggers insisted, however, that both "roots" were obtained from vines almost identical in appearance (although they can distinguish between them), and finally purchasers were compelled to accept them, more especially as the true rhizomata became very scarce. Since then the two rhizomata have been sold indiscriminately, although but little of the original drug is to be found in the market. Eclectic physicians are aware of the difference between these rhizomata and refuse to use the "false" variety,

insisting that it does not possess the medicinal properties, and can not safely be substituted for the "true."—(B. P. I. B. 189.)

Ginseng.—The efforts of the Department of Agriculture in encouraging the cultivation of ginseng have met with gratifying success. An investigation of the subject was begun in 1893 and a report issued in the following year. At that time the Department announced the cultivation of the root as feasible, but could of course give no information as to the manner in which cultivated root would be received in the Chinese market. During the recent years, however, experimentation in ginseng culture has gone steadily on. The cultivated product has been marketed, and the commercial status of cultivated American ginseng established. First-class cultivated roots, dried, have been selling at $5.50 to $6 per pound, slightly in advance of the best wild root. The Department, therefore, fully indorsed the cultivation of American ginseng as an additional resource of the American farmer. The price of ginseng, American exports of which average more than half a million dollars annually, has more than quadrupled in the past thirty years, so that its cultivation, as urged some years ago, has now become profitable. It is clear from this and many similar cases that the native drug industry is capable of either decline or improvement, according to the way in which it is handled. There is a recognized fancy in China in the matter of ginseng. The southern provinces, such as Kwangtung, Kwangsi, and Fukien, take white only; whereas the central provinces, such as Kiangsu, Anhui, Hunan, and Hupeh, prefer the red; and, to satisfy the latter taste, brown instead of white sugar is used for coating the roots while they are being steamed, thereby imparting a pale, reddish tint to the product.—(Y. B. 1898, '99, 1904.)

The American ginseng is a perennial herb, propagated from the roots, which send up each year a new stem bearing at the top leaves, flowers, and finally berries. Plants vary from six to twenty-four inches in height, sometimes reaching a height of two and a half feet to the tops of the fruit cluster. The leaves vary in number with age. The first year a single one with three leaflets is produced. The second year three leaves develop, each with from three to five leaflets. Subsequently, in cultivated plants at least, the number of both leaves and leaflets increases with age, some having as many as seven leaves and eleven leaflets. The flower stem does not appear the first year. It varies from about an inch in length, to seven or eight inches in length, when it extends much above the leaves. It bears, generally, an umbel of small flowers varying in number from about twelve in young plants to more than a hundred in old ones. The berries are one to four-seeded, often flattened when ripe, with a shining surface and of a bright red color, much like flowering dogwood berries. The roots are in general spindle-shaped, but vary extremely with individual plants, and with age of same plant. The young are more generally without forks, and look much like small carrots or parsnips.

Roots from wild plants are in some respects different from

those that have been cultivated. The tendency to branch is somewhat greater, and the disposition of the branches to diverge widely is more pronounced. Cultivated roots from one to five years old show only a short thick neck representing this stem, but it increases with age, and its great length in wild plants indicates that they are old. There can be no question but that the plant can be as easily grown as other cultivated plants, provided it is furnished with the right kind of soil and with shade. No one should undertake ginseng culture unless he has on his land the means of supplying these necessary conditions, or else is willing to incur the expense and trouble of furnishing them artificially. The seeds are gathered from berries on either wild or cultivated plants during the summer and preserved in a slightly damp loose humus, consisting of a mixture of soil and decayed leaves and other vegetation. They must not be allowed to dry out thoroughly at any time. The seed, which ripen during the last half of July, should be planted late in the summer or fall. They germinate after about 18 months. Dead leaves, remains of crumbled logs or the like should be put over the planted ground. In the absence of these, well rotted stable manure may be used. Wild roots may also be gathered (and they grow in the woods in most Northern States and southward to Kentucky, where they may be found almost anywhere) and transplanted in prepared beds with the best results. The wild roots, well prepared, will bring from $2 to $4.50 per pound in domestic markets, while in Japan and China they, and now especially the cultivated ones, frequently bring from $7.50 to $10 per pound.—(Ann. Rept. Ky.)

PART V

MISCELLANEOUS CROPS.

RICE CULTURE.

Rice forms the principal food of one-half the population of the earth. The luxuriant growth of leguminous plants (beans, peas, etc.) at all seasons in tropical climates provides the nitrogenous food elements necessary to supplement rice. A combination of rice and legumes is a much cheaper complete food ration than wheat and meat and can be produced on a much smaller area.

Varieties of Rice.—Rice is an annual plant belonging to the natural family of the grasses. There is an immense number of varieties of cultivated rice, differing in length of the season required for maturing, and in character, yield, and quality. Their divergence not only extends to size, shape, and color of the grain, but to the relative proportion of food constituents and the consequent flavor.

The two principal varieties of lowland rice cultivated in the Atlantic States are the "gold seed," so called from the golden-yellow color of its husk when ripe, and the "white" rice, the original rice introduced into this country in 1694, which has a cream-colored husk and resembles the rice commonly grown in China.

Rice-Growing Sections.—Rice production in the United States is limited to the South Atlantic and Gulf States, where, in some sections, it is the principal cereal product. For nearly one hundred and ninety years after the introduction of rice into the United States, South Carolina and Georgia produced the principal portion, while North Carolina, Florida, Alabama, Mississippi, and Louisiana grew only a limited amount. Within the last ten years Louisiana, Texas, and Arkansas have increased the area devoted to rice to such an extent that they now furnish more than three-fourths of all the product of the country.

Soils Adapted to Rice.—The best soil for rice is a medium loam, containing about 50 per cent of clay. This allows the presence of sufficient humus for the highest fertility without decreasing too much the compact nature of the soil. The alluvial lands along the southern rivers, where they can be drained, are well adapted to rice cultivation. Occasionally such lands are too sandy. The rich drift soils of the Louisiana and Texas prairies have shown a marvelous adaptation to rice.

Showing its wide range of adaptation, rice from the same sack has been planted in moist land and flooded, in cultivated upland fields, and on levees 18 inches above the water; and for a time it grew with almost equal vigor in each of these situations. The principal

difference appeared in the maturing of the seed. Trials have been made with soils covered with a large amount of decayed vegetation. The results were generally disappointing. The roots of the rice, being shallow feeders, did not gain much hold upon the soil, and the decayed vegetation was not adapted to the rice plant. Rice has generally failed on peaty soils. Among the best rice lands of southeastern Louisiana are the so-called buckshot-clay lands, which are so stiff that they can hardly be plowed unless first flooded to soften them up.

The best rice lands are underlain by a semi-impervious subsoil. Otherwise the land can not be satisfactorily drained at time of harvest in order to permit the use of improved harvesting machinery. The alluvial lands along the Mississippi River in Louisiana are not underlain by hardpan, and they can not be drained sufficiently to permit the use of heavy harvesters and teams of horses.

Gravelly or sandy soils are not adapted to rice cultivation because they do not possess the mechanical conditions for the retention of water, and for other reasons above mentioned. Occasionally, on a light sandy soil, underlain by a stiff subsoil, one or two fairly good crops of rice may be grown, but this is the limit.

Rice Lands.—A large proportion of the rice grown in South Carolina and Georgia is produced on tidal deltas. A body of land along some river and sufficiently remote from the sea to be free from salt water is selected with reference to the possibility of flooding it from the river at high tide and of draining it at low tide. Lands of this class are also planted to rice in southern Louisiana.

Inland Marshes.—Some excellent marshes are found in South Carolina and Georgia upon what may relatively be termed high land. These are in most cases easily drained and in many instances can be irrigated from some convenient stream. The objection that planters have found to such tracts is that the water supply is unreliable and not uniform in temperature. In case of drought the supply may be insufficient; in case of freshets the water is too cold. To obviate these objections reservoirs are sometimes constructed, but they are expensive, owing to loss by the evaporation from such a large exposed surface. However, where all the conditions are favorable, it costs less to improve these inland marshes than the delta lands, and the results are fairly remunerative.

Alluvial Lands.—In eastern Louisiana rice is grown largely on low lands which were once used as sugar plantations; also on the well-drained alluvial lands farther up the Mississippi.

Prairie Lands.—In southwestern Louisiana and southeastern Texas is a large area of comparatively level prairie land which has only within recent years been devoted to rice growing. These lands are a sufficient distance from the coast to be free from devastating storms and the serious attack of birds. No expensive clearing, ditching, or leveeing is needed to prepare the lands for rice. The drainage is good and the lands can be cultivated to winter crops, thus preventing the growth of red rice and injurious weeds and grasses. Such cultivation enables the planter to plow deeply in the fall and to

fertilize. Plowing when done in the spring should be shallow. Here the methods of irrigation and culture are different from those employed elsewhere.

Lands for Upland Rice.—The lands which are, or may be, devoted to growing rice without irrigation are so varied in character and location that no description can be given. In general it may be said that rice can be grown on any soil adapted to wheat or cotton provided climatic conditions are favorable. Rice is sometimes planted between the rows of cotton.

Irrigation.—In rice culture the size of the fields depends on circumstances, chief among which are the slope of the land and the character of the soil as regards drainage. Fields range in size from 60 to 80 acres on the level prairies of southwestern Louisiana down to 1 or 2 acres along the banks of the Mississippi River. In oriental countries fields seldom contain more than a half acre. The entire surface of each field should be nearly at the same level so that the irrigation water will stand at about the same depth. Hence, where the slope of the surface is considerable, the fields must be made small. Fields must also be laid off in such a manner as to admit of effective drainage.

Canals and Levees.—In coast-marsh and river-bottom culture a canal is excavated on the outer rim of the tract selected, completely inclosing it. The excavated dirt is thrown upon the outer bank to form a levee. The canal must be of sufficient capacity for irrigation and drainage. The levee must be sufficient not only to inclose the flooding water, but to protect the fields from the encroachment of the river at all seasons. When practicable the rice lands are flooded from the river, and find drainage by a canal or subsidiary stream that enters the river at a lower level. The embankment must be sufficient to protect the rice against freshets or salt water. Freshets are injurious to growing rice, not only because of the volume of water, but by reason of its temperature. A great body of water descending rapidly from the mountains to the sea is several degrees colder than water under the ordinary flow. Any large amount of this cold water admitted to the field not only retards the growth, but is a positive injury to the crop. In periods of continued drought the salt water of the sea frequently ascends the river a considerable distance. Slightly brackish water is not injurious to rice, but salt water is destructive.

The tract of land selected and inclosed is then cut up by smaller canals into fields or subfields of suitable size, a small levee being thrown up on the borders of each. The entire tract is usually level, but if there should be any inequality care must be taken that the surface of each subfield be level. The main canal is 10 to 30 feet wide, about 4 feet deep, and connects with the river by flood gates. Through these canals boats of considerable tonnage have ready access to the entire circuit of the tract, while smaller boats can pass along the subcanals to the several fields. The subcanals are usually from 6 to 10 feet in width and should be nearly as deep as the main canal. Dur-

ing the flooding period the ditches and canals become more or less filled by the mud which flows into them with the water. As soon after harvest as possible the ditch banks should be cleared of foul grasses, weeds, or brush, and the ditches cleaned. The levees should be examined to see if they are in repair.

Preparing the Ground.—The time of plowing differs with different lands and circumstances, but in general it may be said that for wet culture plowing is done in the spring shortly before planting time. In the South Atlantic States, however, the land is often plowed or dug over with a hoe early in the winter. In some parts of southern Louisiana the land is so low and wet and the soil so stiff as to necessitate plowing in the water.

Deep Plowing.—Some planters advocate shallow plowing for rice, because it appears to thrive best in compact earth. Even if this be granted, it does not prove the superiority of shallow over deep plowing. It has been demonstrated that the better the soil and the more thoroughly it is pulverized the better the crop. The roots of annual cultivated plants do not feed much below the plow line; it is therefore evident that deep cultivation places more food within the reach of the plant. If pulverizing the earth deeply be a disadvantage, by reason of the too great porosity of the soil at seeding time, it can be easily remedied by the subsequent use of a heavy roller. If the soil is well drained deep plowing will be found profitable. Deep plowing just before planting sometimes brings too much alkali to the surface. The remedy for this is to plow a little deeper than the previous plowings just after harvest. The alkali will then be washed out before the spring plowing. The plow should be followed in a short time by the disk harrow and then by the smoothing harrow. If the land is allowed to remain in furrows for any considerable time it will bake and can not be brought into that fine tilth so necessary to the best seed conditions. This is particularly true of rice land. If the best results are desired it will be advisable to follow the harrow with a heavy roller. The roller will crush the lumps, make the soil more compact, and conserve the moisture for germinating the grain, rendering it unnecessary to flood for sprouting. For dry culture the land is prepared very much as it is for a crop of oats.

Drainage.—Perfect drainage is one of the most important considerations in rice farming, because upon it depends the proper condition of the soil for planting. It may appear unimportant that a water plant like rice should have aerated and finely pulverized soil for the seed bed, but such is the case. Thorough cultivation seems to be as beneficial to rice as to wheat. Complete and rapid drainage at harvest time allows the crop to be reaped under the best conditions and reduces the expense of the harvest.

Thorough drainage is even more essential for rice than for wheat, because irrigation brings the alkali to the surface to an extent that finally becomes detrimental to the rice plant. Alkali sometimes accumulates in the soil just below the depth of the usual furrow to such an extent that any plowing is dangerous to the crop. Experi-

ence has shown that there is but one effective way of disposing of these salts, and that is by thorough drainage and deep plowing. As the water drains away the excess of soluble salts is carried off. Now if the ditches are no deeper than the ordinary furrow it is evident that only the surface of the soil can be cleared. Either tiling must be employed or there must be plenty of open ditches, the main ones at least 3 feet deep.

Where the lands can not be thoroughly drained after the crop has matured there is liable to be an encroachment of water grasses which will grow so rapidly during the winter that they almost fully possess the field. If the soil can be drained sufficiently to enable the planter to put in a winter cover crop it will be found exceedingly profitable, in addition to preventing the establishment of these injurious grasses.

Sowing.—Too great care can not be exercised in selecting rice for seed. It is indispensable that the seed should be free from red rice, grass, and weed seeds, uniform in quality and size of kernel, well filled, flinty, and free from sun cracks. Uniformity of kernel is more essential in rice than in other cereals, because of the polishing process.

Time to Sow.—The best time to sow rice differs in different sections and varies somewhat with varying conditions in the same section. It may be sown between the middle of March and the middle of May, but in most cases it should be sown by April 20 for the best results. Sowing should take place as soon as possible after spring plowing. Care must be taken to plant the several fields at different periods, so that harvest will not be too crowded. The amount of rice sown per acre varies in different sections and with different methods of sowing, from 1 to 3 bushels per acre being used.

Germination.—Three different methods of treating the seed are followed. Some let on just enough water to saturate the ground immediately after sowing and harrowing and at once draw off any surplus water. This insures the germination of the seed. Others sow and trust to there being sufficient moisture in the land to germinate the seed. This is sometimes uncertain and rarely produces the best results. A few sprout the seed before planting by placing bags of rice in water. This is sure to be a failure if the soil is very dry when the seed is sown. In case of planting in dry soil without following with water saturation, rolling the land after seeding and harrowing has been found beneficial.

Drilling.—The rice should be planted with a drill. It will be more equally distributed and the quantity used to the acre will be exact. The seeds will be planted at a uniform depth and the earth packed over them by the drill roller. It also prevents the birds from taking the seeds. The roller should precede the drill. If it follows the drill the feet of the horses, mules, or oxen drawing the roller will press some of the planted rice 4 or 5 inches deeper into the earth than the general average. Furthermore, the lumps of earth will prevent the uniform operation of the drill. In rice farming too much em-

phasis can not be placed upon the importance of thoroughly pulverizing the soil to a considerable depth; leveling with a harrow as perfectly as possible; crushing all the lumps and packing the surface to conserve the moisture; and planting the seed at a uniform depth.

Broadcast Sowing.—Broadcast sowing of rice is the method most in vogue in many localities, but it should be discontinued; the seed is never scattered with uniformity; some grains remain upon the surface and the remainder is buried by the harrow and the tramp of the teams to depths varying from 1 to 6 inches. Rice sown broadcast does not germinate with any uniformity. Some seeds are taken by the birds, some are too near the surface and lack moisture to germinate, while others are buried too deep. In some instances the variation in the germination of the rice in the same field has been as much as eight weeks. Then at the harvest when the main portion is ready for the reaper a good deal of the rice is still immature. The product commands a very low price in the market, because the merchantable grain must sell at the price of the low grade. It requires much more care to produce a strictly first-class quality of rice than is found necessary in the production of any other cereal, and nearly every fall prime offerings are the exception.

The South Carolina Method.—Seeding in South Carolina commences in April and continues nearly to the middle of May. Just prior to seeding the land is thoroughly harrowed, all clods pulverized, and the surface smoothed. Trenches 12 inches apart and 2 to 3 inches deep are made with 4-inch trenching hoes at right angles to the drains, and the seed is dropped in these. This is usually covered, but occasionally a planter, to save labor, stirs the seed in clayed water, enough clay adhering to the kernels to prevent their floating away when the water is admitted. Great attention is paid to the selection of good seed.

Flooding.—This is the most important distinctive feature of rice culture as compared with the culture of cereals generally. When it is considered that rice can be grown successfully without any irrigation whatever, or with continuous irrigation from the time of sowing till nearly ripe, the wide scope there is for variation in practice will be realized.

General Directions.—Except where water is necessary for germinating the seed, flooding is not practiced until the rice is 6 to 8 inches high. If showers are abundant enough to keep the soil moist it is better to delay flooding till the rice is 8 inches high, as there is considerable danger of scalding the rice when very young. At 8 inches high a sufficient depth of water can be allowed on the field to prevent scalding. The depth of water that should be maintained from the first flooding until it is withdrawn for the harvest depends upon other conditions. If the growing crop thoroughly shades the land, just enough water to keep the soil saturated will answer. To be safe, however, for all portions of the field, it should stand 3 to 6 inches deep, and, to avoid stagnation, it should be renewed by a continuous inflow and outflow. In case the stand of rice is thin the water should

be deeper. A flow of water through the field aids in keeping the body of the water cool and in preventing the growth of injurious plants that thrive in the stagnant water. The water should stand at uniform depth all over the field. Unequal depths of water will cause the crop to ripen at different times.

Where the lands are sufficiently level and have excellent drainage the tillering of the rice can be greatly facilitated by keeping the soil saturated with water but not allowing enough to cover the surface. In this way the crop is frequently nearly double what it would be if allowed to grow dry until tall enough to flood or if flooded before fully tillered.

The Practice in South Carolina.—Under the usual method the water is let on as soon as the seed is covered, and remains on four to six days, till the grain is well sprouted. It is then withdrawn. As soon as the blade is up a few inches the water is sometimes put on for a few days and again withdrawn. The first water is locally called the sprout water. After the rice has two leaves the so-called stretch water, or long-point flow, is put on. At first it is allowed to be deep enough to cover the rice completely—generally from 10 to 12 inches—then it is gradually drawn down to about 6 inches, where it is held twenty to thirty days. It is then withdrawn and the field allowed to dry. When the field is sufficiently dry the rice is hoed thoroughly, all grass and volunteer rice being carefully removed. After hoeing, it remains without irrigation until jointing commences, when it is slightly hoed, care being used to prevent injury to the plants, and the water is then turned on again. During the time water is held on the rice it is changed at least every week to avoid its becoming stagnant. When this occurs rice is liable to be troubled with the water weevil. This lay-by flow, or final irrigation, continues until about eight days before the harvest, when the water is drawn off for the field to dry.

Uniform Ripening.—The planter should particularly note the importance of not making the fields too large. It impedes complete drainage. It is inconvenient to have large ditches intersecting the fields. The simultaneous maturity of all portions of the field is desirable if it is to be cut with a twine binder. This can be secured by uniform and good drainage, by plowing, harrowing, planting, and rolling the same day, and by planting the seed equally deep and distributing it evenly. No field should be so large that the work of planting can not be completed within three or four days. The flooding water must stand in all portions of the field at equal depth and temperature. Rice should be cut when the straw has barely commenced to yellow. If cutting is delayed till the straw shows yellow to the top the grain is reduced in quality and quantity and the straw is less valuable. There is also a considerable increase in the loss by shelling in handling in the field.

Fertilizing.—Rice is not a great impoverisher of the soil, especially if the straw and chaff are regularly returned to it. It has been claimed that the flooding of the rice fields restores to the soil as much nutritive material as the rice crop removes. Where lands are flooded

from rivers like the Mississippi or the Nile, which carry a large amount of silt, this may be true. It is not the case where flooding is done with pure water. The continued fertility of the rice field can only be maintained by restoring to the soil annually a portion of what the crop removes. Whether this can be more economically done by the use of commercial fertilizers and plowing under of the rice straw, or by fallowing occasionally and using some renovating crop as a green manure is an economic question to be determined by each planter according to the conditions presented. Repeated trials of commercial fertilizers have almost invariably shown gains in the quality and quantity of the crop more than sufficient to cover the cost. Summer fallowing, where it can be practiced, is, in addition to its renovating effect, a substantial aid in destroying noxious grasses and red rice.

There is very little exact information on the subject of fertilizers for rice. In Japan and other Oriental countries a large proportion of the rice land is thoroughly fertilized in the fall with straw, leaves, rice hulls, fish, and night soil. The fields are planted to wheat or vetches for the winter crop, followed the next spring by rice without additional manures.

Weedy Grasses.—In all delta rice lands the rapid increase of injurious grasses becomes a serious difficulty. This is intensified along the Mississippi by the large amount and wonderful variety of grass seed in the river water. The conditions favorable to the growth of rice also favor the growth of many grasses, and these wild plants are naturally more hardy than their cultivated competitor. In the early years of rice culture in eastern Louisiana plantations were leased in many instances, and planted a few years while they produced a maximum crop; then they were abandoned for other lands which had not hitherto been planted in rice. This change of lands was due to the rapid increase of harmful grasses, many of which were conveyed to the fields by the irrigating water and appeared to find such congenial conditions for growth that in about three years they were practically in full possession. In a short time it became evident that the practical supply of plantations for such purposes was limited, and that the planters must make a more vigorous and successful warfare on these invaders of their fields. The following are the methods most generally employed against these harmful grasses, with their advantages and defects.

Hand Weeding.—By hand weeding, grasses can be effectually destroyed, and at the same time the rice crop greatly benefited by the loosening up of the soil consequent on pulling up the grass. But hand weeding is too tedious and expensive to be generally employed by the large planters.

Mowing and Burning the Grasses.—After the rice is harvested, some time should be allowed for the growth of grass and suckers from the rice stubble, so that when cut there will be enough straw to burn well. Then the stubble should be cut with a mowing machine and the ground burned over. The fire should destroy not only the seeds but the roots, so that there will be no more suckering. A serious

objection to this plan is that it leaves the land perfectly bare to be parched by the hot sun and baked so hard as to be difficult to plow. It would appear that this difficulty might be removed by sowing a crop of winter oats or other forage crop after burning over the ground. A better plan, provided the field is to remain fallow, is to wait until the grass is killed by frost, then burn over the ground. In this way some seed will be destroyed. Left exposed, some other will be destroyed by ice, and the remainder, feeling the warmth much earlier, will germinate in time to be destroyed by plowing. But this will make the planting comparatively late, and the planter will lose the benefit of the early market for the crop.

Winter Flooding.—Attempts have been made to destroy the grass by flooding the lands during the winter, but the result has been unsatisfactory. It appears that the grass seeds will not rot without germinating, and they will not germinate in cold water.

Early Planting and Mowing.—Planters frequently adopt the plan of sowing early and, when the rice and grass have both got a good start, mowing them off and trusting to the rapid growth of the rice to smother out its slower growing rivals. This it generally does, but its race for life absorbs all its energies and gives it no chance to sucker, thus materially reducing the yield.

Fall Plowing.—Shallow plowing and harrowing or thorough disking immediately after harvest, provided the weather is warm enough for the rapid germination of seeds (not later than September), is quite effective against injurious grasses and red rice. Deep plowing simply buries the seed and preserves it for future growth. The shallower the plowing the better, and if there is not sufficient moisture slight irrigation should be resorted to after the plowing. It will be seen that there are objections to every method described, and some of them are complete failures. Next to hand weeding, the methods which involve the burning over of the ground are doubtless the most effective in eradicating the grass, but summer fallowing with shallow plowing and the employment of some densely growing crop like cowpeas or velvet beans will, all things considered, be the most advantageous for the soil and most efficacious for the eradication of the injurious grasses.

Red Rice.—Red rice, a wild variety having red grains, causes the rice growers much annoyance and loss. The presence of a few red grains in milled rice lowers its grade and reduces its price. If red rice once gets a foothold in a field it increases rapidly from year to year until finally the product becomes unsalable. The red rice and the common white rice are two separate and distinct strains. The seed of one will not produce the other. Being stronger, hardier, and more persistent than the cultivated white rice, the former becomes a dangerous weed in the rice field. Its first start comes from the sowing of seed containing red grains. The fields are reseeded from year to year mainly in this way: After the crop is harvested the stalks which have been cut off frequently send out suckers from the lower joints which mature seed. As these seeds possess remarkable resistance to premature germination, spring finds the ground well sown with red rice.

Remedies.—Two things must be accomplished to keep the field clear of red rice: First, seed planted must be free from red rice, and the utmost caution must be exercised to secure this; second, red seed, if accidentally planted, must be prevented from maturing in the field. To this end it is exceedingly important to prevent a second crop of red seed from maturing after the general harvest, which is almost certain to occur if the field is left fallow till the following winter. The land should be well drained at the time of the harvest, and within a few weeks thereafter the stubble should be plowed under. In October the land should be thoroughly cultivated with a disk harrow and sown to oats for winter pasture. If the harvest be early, the stubble may be plowed under immediately and the field planted to vetches or crimson clover for pasture. In pasturage care should be exercised not to allow any stock on these fields in wet weather. It is quite customary to burn the stubble. This may destroy a few seeds and prevent sprouts from maturing seed, but it destroys fertilizers and leaves the land bare. Fall plowing and planting to forage crops is far more advantageous. Plowing in the early spring and thorough cultivation just before planting are helpful in reducing the red rice, but not sufficient for complete eradication.

While some of the methods mentioned for eradicating weeds and red rice are helpful, none of them has proved completely successful except summer fallowing with cowpeas or planting in corn. This plan increases the fertility of the soil, so that more rice is produced in a series of years than by uninterrupted cropping with rice.

On new land, seed absolutely free from red rice should be used; then, with care, the land may be kept free from it. In case land is already filled with it, if sufficiently well drained, cultivate to corn or cotton a few years; if not sufficiently well drained, summer fallow; if this can not be done, pasture to sheep or hogs. Every rice planter should use great care, in selecting a new piece of ground upon which to raise seed, to choose a plot without possible taint of red. The seed should be examined closely to prevent the sowing of any red seed.

Harvesting.—Reaping machines are generally used in the prairie districts of Louisiana and Texas, but in the other rice-producing sections such machines can be used only to a limited extent, if at all. The principal obstacle to the use of large and heavy machinery is that the ground is not sufficiently dry and firm at harvest time. In some cases the smallness of the fields is also an obstacle.

Where the use of reaping machines is impracticable, the sickle is the implement commonly used in harvesting rice. The rice is cut at 6 to 12 inches from the ground, and the cut grain is laid upon the stubble to keep it off the wet soil and to allow the air to circulate about it. After a day's curing, the grain is removed from the field, care being taken not to bind it while it is wet with dew or rain. The smaller the bundles the better will be the cure.

Care in shocking is also important. Thirty per cent of the crop may be lost by improper shocking. The following directions will aid: First, shock on dry ground; second, brace the bundles carefully

against each other, so as to resist wind or storm; third, let the shock be longest east and west and cap carefully with bundles, allowing the heads of the capping bundles to fall on the north side of the shock to avoid the sun. Exposure of the heads to sun and storm is a large factor in producing sun-cracked and chalky kernels, which reduce the milling value. Slow curing in the shade produces the toughness of kernel necessary to withstand the milling processes. In the shock every head should be shaded and sheltered from storm as much as possible. The rice should be left in the shock till the straw is cured and the kernel hard.

When the weather is dry, ten or twelve days after cutting is sufficient for completely curing the grain. If the weather is damp or rainy, the farmer must use his best judgment in determining the number of days necessary for the curing. Whether stacking rice from the shock is a benefit depends upon the condition of the grain and straw at the time of stacking and how the stacking is done. If too much heat is generated, stacking is an injury. It is, moreover, of less importance with rice than with wheat. Judging from the practice in other countries, rice well cured in the shock and aired after thrashing ought to keep in the bin without heating.

Thrashing.—The primitive methods of flailing, treading out, etc., have largely given place to the use of the steam thrasher, though its use frequently involves considerable loss through breakage and waste of grain. Great care should be exercised to avoid this and preserve every part which has been won from the soil with such labor. At the commencement of thrashing an examination should be made to see that there is no avoidable breakage of the grain. If the rice is damp when delivered from the machine, it should be spread upon a floor and dried before sacking, so as to be in the best condition for the market, for color of grain affects the value. One great mistake made by many farmers is to sack the rice when it is really wet, without airing and drying. They claim that it will dry out in the sack. It will, but drying under such conditions promotes chalkiness and in extreme cases makes the rice almost worthless.

The Question of Labor.—The expense of labor in the rice fields is one of importance to the planter. While American labor is the highest paid in the world, it is also the most effective. The great variations in wages and in the area which can be cultivated by the laborer in different countries are shown in the following table:

Number of Acres One Man Can Farm in Rice, with Wages, in Different Countries.

Country.	Acres.	Farm wages per day, with board.	Country.	Acres.	Farm wages per day, with board.
Japan	½	$0.10 to $0.20	Spain	5	$0.30 to $0.50
China	½ to 2½	.08 to .15	United States:		
Philippines	2½	.25 to .35	Carolinas	8	.60 to .80
India	3	.05 to .10	Arkansas		1.00 to 1.25
Siam	3	.05 to .10	Southwestern Louisiana and Texas	80	1.50 to 2.00
Egypt	4	.20 to .30			
Italy	5	.30 to .50			

These figures show that the high wages paid in the United States need not stand in the way of the extension of the industry.

Yield of Rice.—The yield of rice varies with conditions of soil and climate and methods of culture. The commercial standard weight of "rough rice" is 45 pounds to the bushel. The product is usually put up in sacks or barrels of 162 pounds each. A barrel is a definite quantity—162 pounds. A sack is an indefinite quantity, but usually contains from 150 to 200 pounds. In South Carolina and Georgia the average yield is given as 8 to 12 barrels. Good lands properly managed will give a considerably larger yield. Rice crops on the lowlands along the Mississippi have been produced as high as 30 barrels (4,860 pounds) of rough rice per acre. This was upon good land that had been in peas and had been fall plowed with 6-mule teams. The average product per acre on the lower coast (Mississippi River) will not exceed 8 barrels, and 12 barrels is considered a good crop. The yield in southwestern Louisiana is said by good authority to range from 8 to 18 barrels per acre.

Rice Milling.—The rice as it comes from the thrasher is known as "paddy" or "rough rice." It consists of the grain proper with its close-fitting cuticle roughly inclosed by the somewhat stiff, hard husk. The object of milling is to produce cleaned rice by removing the husk and cuticle and polishing the surface of the grain. The hulls or chaff constitute from 12 to 25 per cent of the weight of the paddy, depending on the variety and condition.

Modern Methods.—The improved processes of milling rice are quite complicated. The paddy is first screened to remove trash and foreign particles. The hulls, or chaff, are removed by rapidly revolving "milling stones" set about two-thirds of the length of a rice grain apart. The product goes over horizontal screens and blowers, which separate the light chaff and the whole and broken kernels. The grain is now of a mixed yellow and white color. To remove the outer skin the grain is put in huge mortars holding from 4 to 6 bushels each and pounded with pestles weighing 350 to 400 pounds. Strange to say, the heavy weight of the pestles breaks very little grain.

When sufficiently decorticated the contents of the mortars, consisting now of flour, fine chaff, and clean rice of a dull, filmy, creamy color, are removed to the flour screens, where the flour is sifted out; and thence to the fine-chaff fan, where the fine chaff is blown out. On account of the heat generated by the heavy frictional process through which it has just passed, the rice next goes to the cooling bins. It remains here for eight or nine hours, and then passes to the brush screens, whence the smallest rice and what little flour is left pass down on one side and the larger rice down the other.

Polishing.—The grain is now clean and ready for the last process—polishing. This is necessary to give the rice its pearly luster, and it makes all the difference imaginable in its appearance. The polishing is effected by friction against the rice of pieces of moose hide or sheepskin, tanned and worked to a wonderful degree of softness, loosely tacked around a revolving double cylinder of wood and wire gauze. From the polishers the rice goes to the separating screens,

composed of different sizes of gauze, where it is divided into its appropriate grades. It is then barreled and is ready for market.

Hulling Machines.—In mills more recently erected the foregoing process has been modified by substituting the "huller" for the mortar and pounder. The huller is a short, cast-iron, horizontal tube with interior ribs and a funnel at one end to admit the rice. Within this tube revolves a shaft with ribs. These ribs are so adjusted that the revolution of the shaft creates the friction necessary to remove the cuticle. The rice passes out of the huller at the end opposite the funnel. It resembles externally a large sausage machine. Six hullers are required for each set of burs. The automatic sacker and weigher is used, sacks instead of barrels being preferred for shipping the cleaned rice.

A Portable Mill.—A portable rice mill has been devised for plantation use, costing $250 to $300, aside from the power to run it, and capable of cleaning 8,100 pounds of paddy rice per day. Such small machines do not give the finish required by the general market, but turn out excellent rice for local use.

By-Products of Rice Culture.—Rice bran contains 12.1 per cent protein, 8.8 per cent fat, and 59.4 per cent fiber and carbohydrates; rice hulls, 3.6 per cent protein, 0.7 per cent fat, 35.7 per cent fiber, and 38.6 per cent other carbohydrates; and rice polish, 11.7 per cent protein, 7.3 per cent fat, and 64.3 per cent fiber and carbohydrates.

Straw.—Rice straw is worth preserving. As a fodder for stock its value is about equal to good southern prairie hay. Rice straw contains 4.72 per cent crude protein, 32.21 per cent carbohydrates, and 1.87 per cent fats. The sweetness and excellent flavor of well-preserved rice straw adds very materially to its practical feeding value, because stock will consume large quantities of it. Digestion experiments have not been made with the straw or any of the by-products of rice milling.

Rice Hulls.—The hulls removed from the rice in the first process of milling possesses a low degree of feeding value, and being also deficient in flavor and digestibility they are of little value as food for stock; they are more valuable as a fertilizer. They not only restore to the land part of the elements of fertility removed by the crop, but increase the porosity of the soil. They also make an excellent mulch for garden and orchard.

Hull Ashes.—In passing through rice-milling districts large quantities of hull ashes will be noticed. These have been very little used by farmers and gardeners, under the general impression that they are of no value. One hundred pounds of hull ashes contain 0.82 pound of phosphoric acid and 0.93 pound of potash. There are many other better sources of potash and phosphoric acid. The amount contained in the hull ashes would not pay the cost of scattering them over the fields.

The planter who burns his straw and sells his rice in the paddy loses 63.92 per cent of the total mineral matter of the crop. If the rice straw and the hulls be returned to the soil as manure, 86.36 per cent of the mineral matter of the crop will be restored, and the loss

would be only 13.64 per cent. The present method of burning rice hulls can not be too severely condemned, but doubtless will be continued as long as rice is sold in the paddy. Hulling is a process requiring very simple and inexpensive machinery. It can be done profitably up on the farm, and is done in most of the great rice-producing countries. In addition to their fertilizing value, the removal of the hull on the farm saves the expense for sacks and freight charge for the extra bulk and weight, the hulls forming generally about 20 per cent of the weight of the paddy. It also enables the farmer as well as the miller to determine with greater exactness the quality of the grain, thereby removing that element of uncertainty which always operates to the detriment of the farmer. It should be mentioned, however, that the hard husk of the rice tends to prevent attacks of weevil on the grain, and that rice with all or a portion of the husks on keeps better in storage or long shipment.

Rice Polish.—This is the fine flour resulting from the polishing process. It is a valuable stock food, being rich in albuminoids as well as carbohydrates.

RICE CULTIVATION IN THE SOUTHWEST.

It is necessary to treat of rice production in southwestern Louisiana and southeastern Texas separately, because the methods are in some respects different from those practiced in any other part of the world.

The soil and climatic conditions in southeastern Texas are almost precisely like those in southwestern Louisiana. Rice culture in this section requires no separate treatment. There is a belt of prairie well suited to rice extending from the Sabine River west for 250 miles or more along the coast. Within a few years large farms have been opened and devoted to this cereal with excellent returns.

Irrigation.—To provide a reliable supply of water, pumping plants for raising water from the streams were gradually put in. The elevation of the prairies above the streams varies from 6 to 38 feet, the larger proportion being from 15 to 25 feet. At first, farms along the streams and lakes were irrigated; gradually large surface canals were constructed. Laterals are run from the main canal to accommodate remote farms. Powerful pumping plants are erected on the bank of the river at the head of the surface canal. These canals, where well constructed and operated, prove entirely successful, and make the rice crop a practical certainty over a large section of country. They range in irrigating capacity from 1,000 to 30,000 acres. The usual water rent charged the planter by the canal company is 324 pounds of rough rice per acre watered.

Deep Wells for Irrigation.—Scarcely had the surface canals been accepted as a success when southwestern Louisiana was startled by the announcement that there were strata of gravel under the surface of the entire section, varying from 125 to 200 feet in some districts to 400 to 600 feet in others, containing a large supply of water which would, of its own pressure, either flow or come so near the surface that it could be readily pumped.

Pipes of 2, 3, 4, 6, and 8 inch size have been sunk to the gravel and pumped continuously for months without serious diminution of the supply. The water is soft, at a constant temperature of about 70° F., and absolutely free from injurious seeds or minerals. Such is the facility with which these wells are made that a 6-inch tube has been put down to the full depth required—200 feet—in fourteen hours. Thus far it has been found that a 6-inch pipe will furnish sufficient water to flood 60 to 80 acres. Such wells are used for the irrigation of other crops than rice.

A 6-inch well will furnish a constant stream for a 4 to 5 inch pump. A system of such wells may be put down 30 to 40 feet apart. Such a combination of wells may be united just below water level, and all be run by one engine and pump. Water rises naturally in these wells to within 20 feet of the surface, and a number of flowing wells have been secured. The lift is not greater than from rivers, lakes, or bayous into canals. Eight 4-inch wells united at the top can be run by one 16-inch pump and a 50-horsepower engine, and will flood 500 or more acres of rice. The total cost of an irrigating plant sufficient for flooding 200 acres is from $2,000 to $3,000. It requires about seventy days' pumping for the rice season.

Harvesting and Thrashing.—The operations of harvesting and thrashing the rice crop in southwestern Louisiana are performed with the self-binder and the steam thrasher. The use of the former is favored by the size of the fields, and by the character of the soil. The use of the latter, while it frequently involves the breakage of considerable grain, is a cheap, rapid, and effective method of separating the rice from the straw. Without the use of such machines the large cultural operations of this section would be impossible.

Prospects for Extension of Rice Industry.—The outlook for the further extension of the industry is very promising. According to the best estimates there are about 10,000,000 acres of land in the five States bordering the Gulf of Mexico well suited to rice cultivation. The amount which can be successfully irrigated by present methods, using the available surface and artesian flows, does not exceed 3,000,000 acres. The balance of the land could probably be brought into cultivation were it necessary, but the cost would, perhaps, be prohibitive at present prices. Three million acres is a conservative estimate of the amount which can be successfully irrigated. The best results require rotation of crops; consequently only one-half of that amount, or 1,500,000 acres, would be in rice at any one time. At an average yield of 10 barrels (of 162 pounds) per acre, 1,500,000 acres of rice would produce nearly 2,500,000,000 pounds of cleaned rice, nearly six times the amount of our present consumption. There is no satisfactory reason why the United States should not grow and mill all of its own rice and become an exporter.

The employment of machinery in the rice fields of the Southwest similar to that used in the great wheat fields of California and the Dakotas is revolutionizing the methods of cultivation and greatly reducing the cost. The American rice grower, employing higher-priced labor than any other rice grower of the world, will ultimately be able

to market his crop at the least cost and the greatest profit. If, in addition, the same relative improvement can be secured in the rice itself, if varieties which yield from 80 to 90 per cent of head rice in the finished product can be successfully introduced, American rice growers will be able to command the highest prices for their product in the markets of the world. In view of the success in this direction of the Kiushu rice experimentally introduced by the Department of Agriculture, more than a hundred tons of this rice have been ordered from Japan by Louisiana planters for the season of 1900.—(F. B. 417.)

(*Additional References.*—F. B. 110; Tex. E. S. B. 122; Hawaii E. S. B. 21, 24; Hawaii Press B. 19.)

THE PEANUT.

Botanically the peanut belongs to the same group of plants as do the beans and peas, but it possesses the character of maturing its fruit or nut beneath the surface of the soil rather than above ground, as do most other leguminous plants. The technical name of the peanut is *Arachis hypogea,* the name indicating the characteristic habit of the plant to mature its fruits underground. The peanut is known under the local names of goober, goober pea, pindar, ground pea, and groundnut. The names goober and goober pea are more properly applied to an allied species having no true stem and only one pea in each pod which has been introduced and is frequently found growing wild in the Gulf Coast States. Properly speaking, the peanut is a pea rather than a nut, the term nut having been added on account of its flavor, which is similar to that of many of the true nuts.

The small yellow flowers of the peanut are borne in the little pocket where the leaves are attached to the stems, and as soon as pollination has taken place the visible portion of the flower fades and falls, after which the short, thick stem that supports the lower portion of the flower elongates and the sharp-pointed ovary is thrust downward into the soil, where the pod develops. Should the ovary fail to reach or penetrate the soil no pod will be formed.

During recent years the area of production of peanuts has greatly increased, especially throughout the warmer parts of the country. The value of the peanut, both as a money crop and for feeding on the farm, renders it especially desirable as a part of the rotation wherever conditions suitable to its development exist.

Soil and Climatic Requirements of the Peanut.—The soil best suited to the peanut is one of a sandy, loamy nature, preferably light or grayish in color rather than dark. Soils that are dark and those carrying a considerable percentage of iron or other mineral are likely to stain the shells of the peanuts, thus rendering them less desirable for the trade. For agricultural purposes, however, the staining of the shells is of little consequence, as it does not materially injure them for stock feeding. In fact, soils that contain considerable clay and lime or are loamy in character produce heavier nuts and sometimes greater yields than do lighter soils. As a rule the peanut does best on a sandy loam with a well-drained clay subsoil, but the crop may be grown under a wide range of soil conditions. Soils that be-

come hard or compact are not adapted to peanut growing, owing to the inability of the pod stems or pegs to penetrate the surface.

Soils that are poorly drained or sour are not suited to the peanut. The ideal soil consists of a sandy loam containing a reasonable amount of humus, or vegetable matter, together with an abundance of lime. A soil having a suitable mechanical consistency is the first essential. Soils lacking in fertility can be improved by a proper cropping system or by the judicious use of manures.

The cultivation of the peanut for commercial purposes has until recently been confined chiefly to areas in Virginia, Tennessee, the Carolinas, and Georgia. During recent years the industry has become established throughout the South Atlantic States and westward to and including California. Over a large part of this section a good grade of marketable nuts can be grown. This area, it will be observed, is one within which the frost-free season is comparatively long, and much of the territory has a soil containing a large percentage of sand or alluvial matter, making it easily cultivated and well adapted to the peculiar habits of the peanut plant. There are undoubtedly many sections outside of this area that can be profitably devoted to the production of peanuts for stock food, and a few regions where they can be grown commercially.

The climatic requirements of the peanut are a long season without frost, a comparatively light rainfall during the growing period, abundant sunshine, and a high temperature. The peanut is slightly more susceptible to injury from frost than the common bunch bean and requires a somewhat longer season for its development. The Spanish peanut will mature in ninety days under the most favorable conditions, but one hundred and ten to one hundred and twenty days should be allowed. The large-podded varieties require a longer period for best results.

Preparation of the Soil.—The time for plowing the land to be planted to peanuts will depend somewhat upon its previous treatment. If the land has been in corn the season before and a crop of crimson clover was sown at the time the corn was laid by, it will be desirable to plow the land just before the clover blooms in order to get the greatest benefit from it as a green manure. If the land is in sod it will be desirable to break it during autumn or winter. If there is no crop on the land the plowing need only be done in time for planting, or rather but a short time before planting, in order to allow the soil to settle. Where a crop of crimson clover is turned under, the soil should be thoroughly harrowed and rolled in order to obtain a compact seed bed and to retain moisture.

Depth of Plowing.—The depth of plowing will depend somewhat upon the character and depth of the surface soil. On sandy soils that are underlaid by a clay subsoil it would be unwise to bring a very great quantity of the subsoil to the surface. If the surface soil is not of sufficient depth, it should be increased by plowing a very little deeper each year until a sufficient depth is reached. As a general rule the depth of plowing for peanuts should not be quite so great as that for corn in the same locality. From 5 to 7 inches of loose

soil will be sufficient for the growing of all varieties of peanuts. Subsoiling may prove beneficial on soils having insufficient drainage.

Preparation for Planting.—When the land is plowed but a short time before planting it should be harrowed within a few hours after plowing, in order to prevent loss by moisture. On loose, sandy soils that are reasonably free from weeds or grass it is often possible to dispense with the regular plowing and cut the land with a disk harrow or disk plow. This implement both cuts and turns the soil, leaving it in fine condition, so that it is readily prepared for planting.

Where plowing is necessary in order to turn under sod, clover, or weeds, a harrow made for smoothing and pulverizing the soil afterwards is superior to the ordinary smoothing harrow in that it turns, crushes, and levels the soil in one operation. By means of a lever the cutting blades can be set to any depth, and the weight of a boy or light man upon the seat is sufficient to secure good work. If the soil is very loose it may be necessary to roll or drag thoroughly before planting.

Under ordinary circumstances level culture should be practiced, but where the drainage is poor it may be advisable to throw up slight ridges upon which to plant peanuts; this is especially desirable during a season of excessive rainfall. When ready for planting, the soil should be in the same general condition as that prepared for a crop of snap or bunch beans. Thorough preparation of the soil is profitable for all crops, and especially for peanuts. If the soil can be harrowed once a week for three or four weeks before planting, most of the weeds that would otherwise injure the crop will be destroyed.

Fertilizers and Preparatory Crops.—Peanuts should be grown in rotation with other crops rather than as a specialty. The cropping system will depend somewhat upon the area of other crops grown, but the arrangement should be such that the land will be planted to peanuts one year in each three or four. A good rotation is corn or cotton the first year with cowpeas, crimson clover, or bur clover planted between the rows at the time of the last cultivation; the next season plow under the cover crop and plant the land to peanuts; as soon as the peanuts are harvested sow the land with rye and use as a winter pasture; plow under the rye during the springtime and plant cowpeas, using the peas as a hog pasture during the autumn; then return to corn or cotton the following year. In order to get the greatest benefit from a crop of crimson or bur clover it should remain on the land in the spring until a heavy growth has been made. It is not desirable to plant peanuts immediately after turning under a heavy growth of clover, and planting should be deferred until the land has had sufficient time to settle and the green manure to decay partially, or a rotation should be followed in which the peanuts do not come upon the land until the following year.

In the Gulf Coast States the rotation may consist of corn and cowpeas, followed by winter oats. The oats will ripen in June or early in July, in time to grow a crop of Spanish peanuts. The next season, plant cotton and sow crimson or bur clover at the time of the final

cultivation. The following spring, the clover may be turned under, the land planted to corn, and the rotation repeated.

Another plan would be to devote the land one year to sweet potatoes or to a crop of early Irish potatoes followed by cowpeas. In this rotation stable manure should be applied to the crop of corn or cotton, and the commercial fertilizers with the peanut and potato crops. Peanuts should, if possible, follow some well-cultivated crop which has been kept free from weeds.

Stable or barnyard manure should not be used as a fertilizer the same year that the land is planted to peanuts, owing to the great number of weed seed that are contained in the manure. The use of manure also has a tendency to cause the plants to produce abnormal tops and a large percentage of poorly filled pods, known to the trade as "saps" or "pops." The proper time for applying stable manure is with the crop grown the previous season, thus giving it time to become incorporated with the soil and reduced to the proper condition for the peanut crop.

Commercial Fertilizers.—The peanut responds to the use of commercial fertilizers. However, a reasonable amount of humus in the soil is essential. If properly handled, the peanut crop is not exhaustive of soil fertility; in fact, the plant is a great nitrogen gatherer, as may be observed by the large number of nodules upon the roots. On the other hand, if the entire plant, including the root, is removed and no part returned to the soil the peanut becomes almost as exhaustive of soil fertility as corn. By feeding the straw and other refuse from the crop to cattle, hogs, and work animals and applying the manure thus obtained to the land the fertility may be retained or even increased.

The nitrogen-gathering bacteria are usually present in abundance, even where the crop is planted for the first time, but should the nodules not be abundant artificial inoculation would prove an advantage. On soils that are adapted to the production of peanuts it will not be necessary to employ commercial fertilizers in large quantities. The alluvial and overflow lands found along the rivers of the Southwest seem to be well supplied with all the elements necessary for the production of peanuts. On the sandy hill lands of this region it will be necessary to add fertilizers and lime in varying quantities.

A commercial fertilizer adapted to the production of potatoes is as a rule suited for the growing of peanuts. A mixture which contains from 2 to 3 per cent of available nitrogen, 5 to 7 per cent of available phosphoric acid, and 6 to 10 per cent of potash is desirable; this should be applied at the rate of from 200 to 800 pounds to the acre, according to the needs of the land. Most growers follow the practice of scattering the fertilizer in a narrow strip where the row is to be planted, often using a one-horse fertilizer distributer for the purpose. It is important that the fertilizer be thoroughly mixed with the soil.

Importance of Lime in the Soil.—In order to insure the proper filling and ripening of the pods, peanuts require an abundance of lime in the soil. Where the soil is of a calcareous nature, containing

limestone, shells, or lime in its more active form, it may not be necessary to make a regular application, but on soils that are deficient in lime or inclined to be in the least sour, from 600 to 1,000 pounds of fresh-burned lime should be applied to an acre every four or five years. The presence on the land of certain weeds, such as the common sorrel and the sedges (which have three-cornered stems), indicates sourness and insufficient drainage; to correct this an application of lime will be necessary in addition to ditching or tile draining. The lime should not be put on at the same time as the commercial fertilizers, but rather during the previous autumn, or at the time of plowing the land. Where deposits of marl are found this may be used as a substitute for lime. In Virginia the marl is hauled and scattered broadcast upon the land during the winter months.

Wood ashes are desirable as a fertilizer for peanuts, as they contain both potash and lime. Unleached wood ashes may be applied broadcast at the rate of 1,000 to 1,200 pounds, 25 to 30 bushels, to the acre.

Lime should be used on land that is to be planted to peanuts, unless it is definitely known that there is an abundance of it already present. In the river valleys of the boll-weevil district there appears to be an abundance of lime present in the soil.

The Peanut as a Nitrogen Gatherer.—The peanut plant, in common with other leguminous plants, has the power of collecting the free nitrogen of the atmosphere and storing it in little nodules upon its roots. For this reason the peanut is one of the more desirable of our soil-renovating and soil-improving plants. It should be borne in mind, however, that in order to benefit the soil the nitrogen so gathered should not be removed, but that the main portion of the roots should be left in the soil.

The Seed and Its Selection.—A good grade of seed is just as important with the peanut as with corn, wheat, or any other crop. There is perhaps no other farm crop except corn that is so greatly influenced by the character of seed planted as the peanut. The very best peanuts of the previous season's crop should be selected for seed, and of these only the most mature and perfect peas should be used. Seed should be saved only from well-ripened and mature plants and should be properly cured and kept dry during the winter months. Good seed produces a more even stand of plants, which in itself returns a greater yield.

The seed should not only be selected from plants that are mature, but from those producing a large number of mature pods as well. By doubling the number of well-filled pods on each plant the yield for each acre will also be doubled. Many millions of bushels have been added to the corn crop of the country simply through the selection and improvement of seed. What has been done with corn is possible with the peanut, and where we now have an average yield of 34 bushels to the acre it is reasonable to expect this to be increased to 50 or 60 bushels through seed and cultural improvements.

Planting Shelled or Whole Seed.—In planting the large-pod varieties it is desirable for several reasons that the seed be shelled. In

the first place, the planting machines now in general use are adapted to handling the shelled seed only. Second, when planting whole pods there is always a doubt regarding their being well filled, and a poor stand may result. Third, pods containing two or more seeds will produce more than one plant in a hill, causing a waste of seed and a crowding together of the plants. Fourth, whole seed is slower in germinating than shelled seed. With the Spanish variety the case is quite different, as the pods are invariably filled, the crowding together of the plants is no great disadvantage, and the few days' extra time required for germination is of little consequence.

Virginia nuts intended for seed should always be shelled by hand, but the Spanish are sometimes shelled by machinery, although their germination is invariably injured when so handled. Many growers of the Spanish peanut practice soaking the unshelled nuts in water previous to planting. Soaking for a few hours will hasten germination, but if for any reason the seed can not be planted immediately it will be lost. Shelled seed should never be soaked before planting.

Time and Methods of Planting.—The time for planting peanuts is in the spring after the soil has become thoroughly warm. In order to secure a good stand, the seed should not be put in the ground until there is sufficient warmth to germinate it quickly. As a rule peanuts should be planted a trifle later than corn and beans. The Spanish variety may be planted somewhat later than the Virginia type, as it requires less time to complete its growth. As previously mentioned, the Spanish and similar varieties may in certain localities be planted after oats—that is, from the middle of June to the 10th of July. The Virginias or large sorts should, if possible, be planted before May 20 for the best results.

Distance to Plant.—A common distance between rows is 36 inches, but this varies somewhat according to the soil and variety. For the Virginia Runner variety on good soil the distance between rows should be at least 36 inches, and 16 inches between the plants in the rows. Virginia Bunch peanuts may be in rows as close together as 30 inches, and 9 to 12 inches apart in the rows. The Spanish and Tennessee Red varieties are planted in rows from 28 to 36 inches apart and 9 to 12 inches apart in the rows, according to the fertility of the soil. On rich soils, where the spread of vine will be great, the maximum distance between rows as well as between plants in the row should be allowed.

Quantity of Seed Required.—The quantity of seed peanuts required to plant an acre will depend somewhat upon the distance of planting. As a rule 1½ pecks of shelled Virginia peas will plant an acre. One peck of shelled Spanish peanuts, or 1¼ bushels in the pods, are required for an acre. The greater the care exercised in planting, the smaller will be the waste of seed, and economy is quite an object when planting specially selected or high-priced seed. By planting the Spanish variety in the pod two seeds will be placed together in a hill, but there can be no very great objection to this, as

the two plants will generally give a better yield than where the plants grow singly.

Depth to Cover the Seed.—The depth to which the seed should be covered will depend somewhat upon the character of the soil. On heavy soils three-fourths inch to 1¼ inches will be sufficient, while on light sandy soils 1½ to 2 inches may not be too deep.

Tools and Methods of Planting.—Peanuts are generally planted in rows that are cultivated in one direction only. Some growers follow the practice of first marking the land with an implement similar to the ordinary corn marker. Others open a furrow with a one-horse plow, then after the fertilizer has been distributed in the furrow the plow is again used and a slight ridge thrown up. There is now on the market a tool of a type which sows the fertilizer, throws up a slight ridge, and at the same time indicates the position of the next row. The greater portion of the peanut crop is planted with the one-horse planters. These machines are similar in many respects to a cotton planter. Where the Spanish and similar varieties are planted in the shell the usual method is to open a small furrow, drop the seed by hand, then cover it by means of a small harrow or cultivator with a notched board fastened across the back of the implement.

General Cultivation.—Cultivation of the peanut crop should begin immediately after planting and continue until the vines occupy the ground. The work of cultivation should be pursued very much the same as for corn, beans, and all similar crops. Frequent shallow cultivation that will keep the soil loose and prevent the loss of moisture is essential. Shortly after rains the surface soil should be stirred and during dry weather a dust mulch maintained. During the later cultivations it will be desirable to work the soil toward the rows to provide a bed of loose earth in which the pods may form.

After the peanuts begin to peg, or form pods, they should not be disturbed or given further cultivation. The old idea that the blossoms of the peanut must be covered is erroneous, although growers frequently allow considerable soil to be thrown over the vines during the final cultivation. For the last cultivation it is a common practice to employ a tool that will both throw the soil toward the rows and leave a furrow in the middle of the alley to carry off water during heavy rains. Common crab-grass is one of the most troublesome weeds of the peanut fields, and it is often necessary to resort to hand hoeing in order to keep this and other weeds out of the rows. If the crop is kept well worked with horse tools, very little hand labor will be required.

Tools Adapted to Cultivating Peanuts.—Most implements that are adapted to the cultivation of corn or cotton will be found suitable for handling the peanut crop. For the first two or three cultivations a one-horse weeder of special type may be used crosswise of the rows. After the plants are tall enough so the rows can be followed, a spring-tooth riding cultivator is desirable, while for the later workings the same implement can be used by changing the spring teeth for regular cultivator shovels. For one-horse cultivation the ordinary cotton sweep is frequently used, but a cultivator provided with several styles

of narrow and broad shovels, sweeps, and hillers, making it possible to adapt it to the requirements of a wide range of conditions will do more efficient work.

Some growers follow the practice of running a light roller over the plants after the final cultivation, the object being to flatten the stems upon the ground in order that the little pods forming on the extremities of the stems may reach the soil. This practice may increase the yield, but it will also increase the percentage of "saps," or unfilled pods, and it is doubtful if anything is gained by the practice.

Harvesting.—No fixed rule can be given by which to determine when to remove the peanut crop from the ground, and each grower must be his own judge in the matter. In general practice the growers aim to dig before the first frosts, in order that the peanut vines may have greater value for stock food. To the southward, where frosts do not appear until quite late, the vines assume a yellowish appearance during the latter part of the season, which indicates the ripening of the peas. If digging is deferred too long, the first-formed peas are likely to burst their shells and start growing; this is especially true if there is a period of rainy weather late in the season. The aim should be to dig at the time the vines have upon them the greatest number of mature peas. Where a large acreage is grown it will be necessary to begin harvesting as soon as the earliest peas are ready, in order to complete the work before unfavorable weather sets in.

Methods Employed for Lifting the Plants.—Under ordinary circumstances the peanut vines are plowed from the ground with a one-horse turning plow and afterwards separated from the soil by hand. Many growers employ either a two-horse plow similar to that frequently used for digging potatoes or a turning plow with the mold-board removed to prevent a furrow being turned. Behind the digger or plow a gang of workmen shake the vines and peas free from the soil and throw them in small bunches. In this manner a team and driver accompanied by eight or ten hands will dig from 5 to 7 acres a day at a cost of about $2.50 an acre.

It has been found by experiment that the regular machine potato digger drawn by two or three horses driven by one man will dig from 8 to 12 acres a day and do the work in a much cleaner and better manner than the old plow and hand method. This machine not only removes the peanuts from the ground in a more perfect manner but also shakes off the soil, leaving the vines lying loosely upon the surface of the ground. By the hand method a few pods become detached from the vines, while with the machine potato digger scarcely a pod is lost. Almost any of the machine potato diggers may be used for digging peanuts, but where the vines of the "runner" peas are exceptionally heavy there may be some difficulty in getting the vines through the machine. This difficulty may be overcome by providing disks or cutters to cut away the ends of the vines in front of the machine.

Special machines are now being offered which are intended to dig, clean, and bunch the peanuts. By setting any of these machines

to the proper depth it is possible to sever the main root of the peanut just below where the pods are formed and thus leave considerable of the accumulated nitrogen in the soil. It is estimated that the nitrogen left in the soil by this system has a fertilizing value of from $3 to $8 an acre.

Several local devices have been constructed, usually upon the plan of an ordinary plow, but having a U-shaped blade or cutter with one edge sharpened and so mounted that it may run underneath the peanut plants. It is desirable to use a double team, straddling the row, so that the digger will run at a uniform depth. Almost any blacksmith can construct a tool of this kind and it should not cost more than $5 or $6. Any device that will sever the roots of the peanut just below where the peas are formed will answer the purpose and prove better adapted to the work than the plow. Past methods as practiced in Virginia, where the peanuts are removed by means of an ordinary plow, taking most of the nitrogen from the soil, are largely responsible for the rapid depletion of soil fertility in those lands.

Curing Process and Care of Crop After Digging.—After the peanut vines are loosened from the soil they are allowed to lie either spread upon the ground or in small bunches for three or four hours, and are then placed in small stacks around a central stake to cure. If the peas are allowed to lie exposed to the weather for any length of time after digging, the pods become discolored and lose in weight.

A better grade of peanut hay will be secured if the vines are placed in the small stacks as soon as the leaves and stems are thoroughly free from dew or other surface moisture. Most growers follow the practice of putting the peas in stacks the same day they are removed from the soil, or those dug during the morning are stacked in the afternoon and those dug later in the day are stacked the following morning as soon as they are free from dew; however, any dew or rain will discolor the pods.

The essentials in caring for the crop during the curing period are that the peanuts be kept in small stacks, given an abundance of air, and protected from both the weather and injury from animals. Owing to the fleshy nature of the stems they cure quite slowly and are liable to mildew if placed in large lots.

The supply of stakes should be ready in advance and may be kept for use from year to year. These stakes should consist of split or round poles about 3 or 4 inches in diameter, 7 feet in length, and sharpened at both ends. For setting the stakes in the ground a pointed bar of iron or a crowbar with which to make the holes is used. The stakes should be set in the ground to a depth of 12 to 14 inches and well tamped to make them firm and solid.

Before starting the stack one or two pieces of lath about 18 inches in length are nailed at right angles to the stake 8 inches from the ground, in order to prevent the peanuts coming in direct contact with the soil. In starting to build the stack a few vines are laid across the pieces of lath and the stack then built up by successive layers of vines, the pods being kept well to the center against the stake and the tops to the outside. The stems should have sufficient outward slope

to shed water. Occasionally a few vines should be hung around the stake in order to tie the stack together. By this method the pods will be near the center and around the stake, where there is an upward circulation of air and general protection. When the stack has reached the desired height, a bunch of vines is rolled together and pressed down over the point of the stake to form a top, or a little dry grass or weeds may be used for this purpose.

It is not advisable to use anything for topping out the small stacks that will prevent the circulation of air. A heavy cover or a covering of green or wet hay will invariably cause the peanuts to spoil.

The majority of growers follow the practice of placing the stacks singly in rows in the field where the crop is grown; others arrange them in groups of from four to ten, while some growers haul the crop to a stacking yard, where the stacks are built closely together.

Storage in barns is not advisable, either when curing peanuts for market or where the entire plant is fed to stock, as the crop may be handled more economically and a better grade of hay produced by putting it up in the small stacks. After the peanuts have cured in the stacks from four to six weeks, those intended for feeding to stock may be placed in barns.

Picking and Cleaning.—Peanuts for market should be cured in the stack at least three or four weeks before picking. If the weather is dry and windy immediately after harvesting, the curing process will be quite rapid, but should the weather conditions be unfavorable during this period the pods will ripen more slowly. Too rapid curing is not desirable, as the pods are likely to shrivel and discolor. Peanuts should not be picked from the vines until the pods have become dry and the peas firm and nutty, with the immature ones more or less shrunken. As a rule very little is to be gained by early marketing, and a better grade of peanuts will be secured if picking is deferred until late autumn. If the pods are not well protected in stacking, many will be destroyed by the common crow. In some sections it is necessary to pick as early as possible to prevent heavy loss from the ravages of field mice and rats while the peanuts are in the stack. If peanuts are not well stacked the pods are liable to become discolored by the heavy fogs and driving rains of late autumn. The stacks should not be opened nor the vines handled during wet weather.

Picking by Hand.—The standard of excellence in the peanut markets is always based upon hand-picked stock, but with the present scarcity of labor and rapid improvement in peanut-picking machinery the time has come when a uniform price is paid for a given quality of peas regardless of how the picking is done. Hand picking is at best a dusty and laborious task and is usually done by the women and children. Where the vines are well set with pods a good picker will handle from 8 to 12 bushels a day. The cost of picking the peanuts grown on an acre will vary from $4 to $8.

Use of Machines for Picking.—Two types of machine are employed for picking peanuts from the vines. A cylinder machine similar to regular grain separator except as to size has been used for sev-

eral years, especially in the districts where the Spanish variety is extensively grown. The principal objection to all the cylinder machines is the tendency to break the pods and both shell and injure the peas. By running the cylinder quite slowly, say at 400 revolutions a minute, and feeding properly it is possible to thrash peanuts by using a cylinder machine with a very small percentage of loss from breakage. Pods that are merely cracked or that have what the growers term oyster mouths will not keep for a long period but become rancid or are injured by small insects while in storage.

There are machines in use which work upon an entirely different principle from the cylinder machines and which do not break or injure the pods. In these machines the picking is done by dragging the vines over a horizontal wire mesh, and at the same time brushes act on the lower side of the wire screen to remove the nuts. Very little power is required to operate these machines, two complete outfits being run at once by an 8-horsepower gasoline engine. The capacity of these machines is from 250 to 500 bushels a day. In addition to removing the pods from the vines the machine has the usual cleaning arrangements and a device for removing the small stems from the pods, delivering them in a condition suitable for the cleaning factory.

Care of Peanuts After Picking.—At no time after the curing process should the peanut pods be exposed to water, or even dampness, as the shells invariably become darkened and discolored by the addition of moisture. When properly cured the shells will be covered with a fine, dry dust and where this dust becomes moistened it adheres and forms a brownish spot. If the peanuts show the least trace of dampness after their removal from the vines, they should be spread on a floor or stored in a well-ventilated building until thoroughly dry. Many of the larger growers have provided narrow cribs similar to those employed for the storage of corn, and the peanuts are kept in bulk until sold. When the pods are thoroughly dry they may be put into bags as they come from the machine, and either hauled direct to the cleaning factory or stored in small lots.

Preparation of Peanuts for Market.—As the peanuts come from the hands of the pickers or the thrasher they contain considerable rubbish and have more or less soil adhering to the pods. The extent to which the pods must be cleaned and graded will depend upon the use to which they are to be put; if for vending purposes they will require a factory process, but if for shelled nuts very little work will be necessary to prepare them for the sheller. Under the present status and extent of the peanut industry the cleaning factory has become an important factor, and the interests of the grower and cleaner are correlative and should be cooperative. Where Spanish peanuts are grown on an extensive scale it may be feasible for the farmer to own and operate a small shelling and cleaning outfit. In the case of the large-podded varieties several grades are made from one class of stock, requiring an extensive, although simple, equipment and the handling of large quantities of nuts in order to make the enterprise profitable.

Cleaned Vines as Stock Feed.—The peanut vine or straw from which the nuts have been removed is of considerable value for feed-

ing purposes. Where the peanuts are picked from the vines by hand the stems become broken and the greater portion of the leaves is lost, but where machines are used for picking it is possible to save the straw in fairly good shape. If the vines are carefully handled during the curing process and then put in barns or stacks that keep out rain, the straw when delivered from the thrasher will have a feeding value about equal to clover hay. If the vines are bright and clean after the pods have been removed they can either be sold or fed to farm animals, and they will in this way partially pay for the cost of planting and cultivating the crop. Some growers employ a baling press and bale the straw as it comes from the thrasher in order that it may be more easily stored and also be available for marketing.

Varieties of Peanuts.—There are not more than five or six distinct varieties of the peanut grown in the United States, but these few varieties represent at least three separate types. By classifying the varieties of peanuts according to types we have first the large-podded, or Jumbo, peas and the small-podded peas. These types are subdivided into bunch and running peas. Those varieties having a bunch habit of growth are most generally grown, owing to the fact that they may be planted closer together than the runner varieties. The bunch varieties are also more easily cultivated and harvested than the runner varieties. The following descriptions of the more common varieties of the peanut may be of interest to those not already familiar with them:

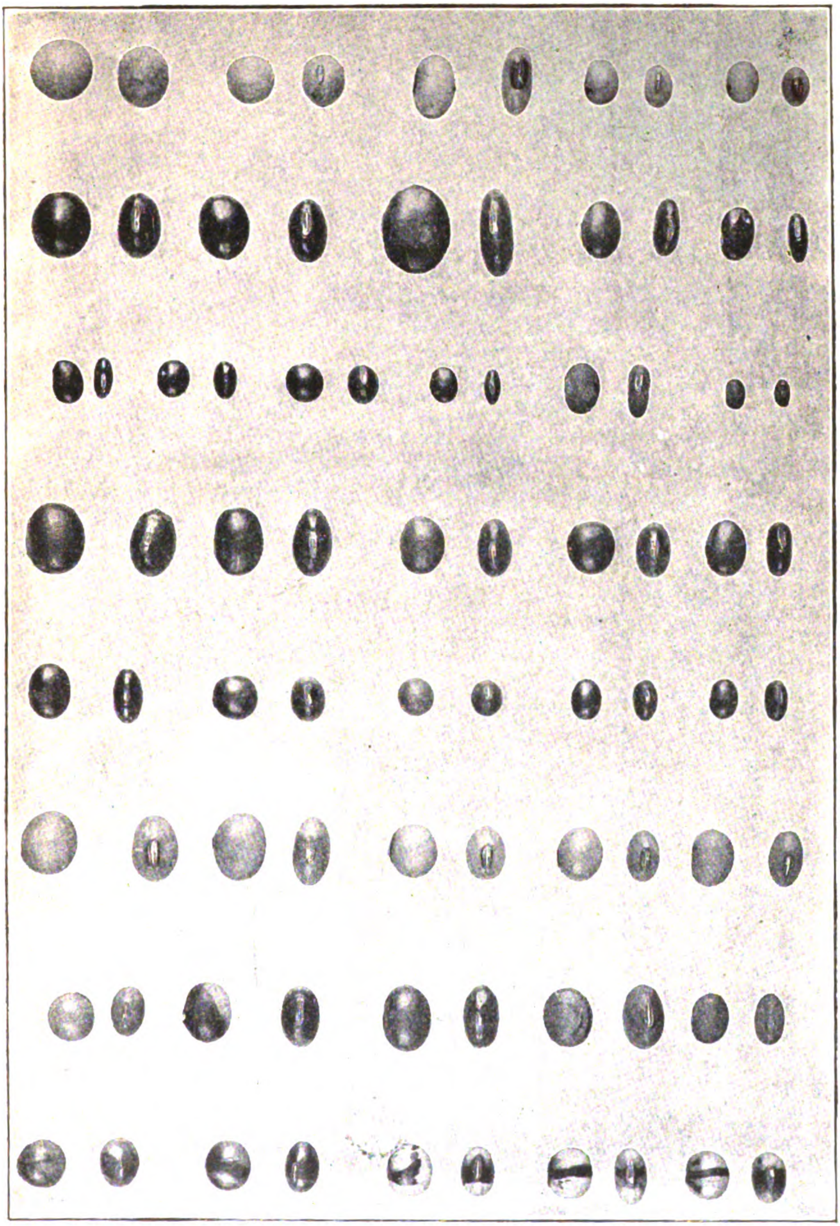
Virginia Bunch.—Large-podded variety, plant rather dwarf, stems upright, foliage rather light; pods clustered about the base of plant; usually two, sometimes three, seeds in a pod, pod bright and clean, color of peas light brown; pods adhere well to plant in digging. The customary weight per bushel of this variety is 22 pounds.

Virginia Runner.—Large-podded variety, strong grower, stems creeping, foliage heavy; pods scattered along procumbent stems; pods and peas very similar to those of the Virginia Bunch; pods do not adhere well in digging. The customary weight per bushel of this variety is 22 pounds.

Spanish.—Small-podded variety, strong grower, stems upright, foliage abundant and heavy; pods clustered about base of plant; usually two seeds in a pod, entirely filling the pod; color of peas light brown; pods adhere well to plant in digging. This variety frequently yields 60 bushels of marketable peas and a ton of hay to the acre. The peas of this variety are rich in oil content. The weight per bushel of Spanish peanuts is 30 pounds.

Tennessee Red.—Small-podded variety; similar to Spanish, except that the pods are longer, sometimes containing five or six peas crowded together; peas dull red in color. This variety is well adapted to stock feeding, but does not sell upon the market owing to the color and quality of the peas.

Valencia.—A very promising new variety introduced from Spain. Similar in many respects to the Tennessee Red, but of much better quality. A desirable sort for the manufacture of peanut butter,



Seeds of 36 Varieties of Soy Beans, Showing Variation in Size and Form.
Bottom Row Peculiarly Colored.

(See pages 82-96.)

also blanched and salted peanuts. A heavy yielder and matures in about 120 days.

African, or North Carolina.—A variety that is much grown in Africa for oil production. A very rank grower, the stems spreading over the ground. Foliage dark green and massive. Pods form along the stems similar to the Virginia Runner. The pod is of medium size and generally contains two peas, sometimes three. Rich in oil and of excellent flavor. This variety requires a long season for its development and should be planted quite early.

Varieties for Marketing.—For vending purposes, where the peas are roasted and sold from the fruit stands, the large-podded varieties, including Virginia Bunch and Virginia Runner, are in greatest demand, although considerable quantities of Spanish and North Carolina are used for this purpose. For shelled peas the smaller nuts of the large-podded stock are employed; also the greater part of the crop of Spanish, North Carolina, and Tennessee Red varieties. A large percentage of the shelled stock is of the Spanish variety.

Varieties for Stock Feeding.—When peanuts are grown exclusively for feeding purposes the Spanish is undoubtedly to be preferred. If it is desired to market the high-grade portion of the crop and feed the remainder, the question of variety to be grown will depend largely upon locality. Many growers throughout the peanut area follow the practice of planting several acres of Spanish peanuts and disposing of all of the better-grade peas to some factory for shelling purposes, the vines and poorly filled pods being fed to farm animals. The Spanish peanut can be grown under a much broader range of conditions than the large-podded sorts and should be employed where the season is short.

This variety also produces a heavy yield of vine and is desirable for forage purposes. The Valencia is very similar to the Spanish variety in habit of growth, is desirable for stock feeding, and is rapidly finding a place in all branches of the market with the exception of the retail trade in roasted peanuts.

The Uses of the Peanut.—To most persons the peanut suggests only the article as it appears for sale whole or shelled and salted, but during recent years the uses of peanuts have become numerous, and include a wide range of utility. The demand for peanuts for use in the manufacture of food preparations is constantly increasing. By-products of the peanut are now being employed extensively in the manufacture of feeds for farm stock and dairy cows, and the plant is being largely utilized as forage and as a soil renovator.

Important Uses for Human Food.—Among the more important uses of the peanut for human food are the following: It is eaten from the shell, as salted shelled peas, as blanched peas, in the so-called peanut candies and brittle, in combination with pop corn and puffed rice, in the form of peanut butter, and as an ingredient of peanut and vegetable meats, peanut meal, and salad oils.

The use of the peanut for eating from the shell when roasted is most important and popular, but the quantity of shelled peas that are first roasted and then salted and sold by the pound is constantly

increasing. Comparatively small quantities of the better grades of peanuts are first shelled and then roasted and the thin brown covering removed, after which the halves of the peas are broken apart and the small germ removed, giving the meats a blanched appearance which renders them very desirable for table use.

Great quantities of shelled peas are used every year in the manufacture of peanut candies and brittle, both alone and in combination with other nuts, pop corn, or puffed rice. A very desirable kind of peanut candy can be made by simply boiling shelled peanuts with a thick sirup consisting of 2 pounds of granulated sugar and one large cupful of water, together with a teaspoonful of lemon juice. When the sirup begins to boil add 2 pounds of unroasted shelled peas and cook slowly until the peas are tender and the sirup sufficiently hard to break when quite cold. The cooking process should as a rule continue for about an hour, when the mixture should be poured on a cold buttered platter to cool. Peanut candies as a rule are not adapted to handling in warm weather and should be kept cold after making.

During recent years great quantities of shelled peanuts, especially of the Spanish variety, have been employed for the manufacture of peanut butter. This butter is prepared by the ton in factories, is put up in bottles or tins containing from one-fourth pound to 5 pounds each, and has become very popular as a part of the luncheon menu and for camping and cruising supplies. In the process of the manufacture of peanut butter the peas are first given a medium roast, care being taken that the meats do not become overdone or scorched. The peas are then fanned and screened to remove the thin brown coverings and the germs, after which they are ground to a pulp by means of a special grinder similar to those used for chopping meats. As the peanut pulp comes from the grinder it is fed through a tin tube into the bottles or tins and tightly sealed. Some manufacturers follow the practice of salting the peanut butter, while others leave this part of the process for the consumer, who can easily salt to suit the taste.

By a little experience and the aid of a small meat grinder, any one can make good peanut butter for home use. The peanuts may be roasted before or after shelling, but in either case the oven should be only moderately hot and the peas should be stirred frequently. After roasting, rub off the skins and screen out the small germs, or hearts. In grinding use the finest plate on the grinder and screw up the tension until the crank will be quite hard to turn. If the pulp is too coarse after one grinding it may be run through a second time. It will not be necessary to add anything but a little salt to the butter, but if desired the butter may be thinned by the addition of a little olive or peanut oil.

In the preparation of vegetarian meats a portion of the oil is expressed from the ground peanuts, other ingredients, including various vegetable substances, are added, and the whole is crushed and pressed into tins ready for use. In this case the extra oil is either used for thinning peanut butter or sold as a compound for use in further cooking the vegetable meats. Peanut meal, made from finely ground blanched peanut meats, is used to some extent in confections. This

meal is especially desirable in the manufacture of almond macaroons and small cakes, to which it imparts the desired almond flavor. It is also used in the manufacture of candies. Peanut oil is used in the same manner as olive oil; also for mixing with cottonseed oil in order to improve the quality of the cottonseed oil for salad purposes.

The Uses of Peanut By-Products as Foods for Live Stock.—In the factories where peanuts are cleaned, shelled, and graded ready for the market there is always a certain percentage of cleanings and inferior stock that can readily be turned into stock foods. The outside shell, or hull, of the peanut is rich in food materials, but is extremely difficult to reduce to a condition in which it can be fed. In large cleaning factories the shells are generally used as fuel, and the ash resulting therefrom is valuable as a fertilizer, often containing as high as 3 per cent of phosphoric acid, 9 per cent of potash, and 6 per cent of lime.

The thin brown covering of the peas has a feeding value almost equal to that of wheat bran. These hulls are especially desirable for mixing with the smaller particles of broken peas for stock feeding. In large factories where peanuts are prepared for the manufacture of peanut butter and similar preparations the waste in the form of small particles of the meats and the germs is considerable and this is sold to farmers for feeding purposes. In some cases the waste is mixed with a portion of the hulls and finely ground or chopped before leaving the factory. Peanut hulls make an excellent bedding for use in stables, and by using them in this manner and hauling the manure upon the land their full value can be obtained.

Broken peas and germs are used largely as a food for hogs, but both should be fed in moderation and in combination with some grain, as the peanut fed by itself will produce a hog having soft fat and inferior meat. The famous Smithfield hams and bacon come from hogs that are fed partly on peanuts, the practice being to turn the hogs into the peanut fields after the crop has been gathered and allow them to glean the pods that were lost in harvesting. The principal objection to the use of peanut by-products as stock feed is their tendency to become rancid very quickly. The germs, which are high in nitrogen content, become rancid and bitter in a short while and should not be kept on hand for a greater period than fifty or sixty days.

Possibilities in the Manufacture of Peanut Oil.—The oil of the peanut belongs commercially in the same class as cottonseed and olive oils. Peanut oil is of a higher grade than cottonseed oil and of somewhat lower value than first-class olive oil. Peanut oil is sometimes used for mixing with olive oil for the production of an oil that can be sold at a lower price than pure olive oil. On the other hand, peanut oil is frequently mixed with cottonseed oil in order to improve the quality of the cottonseed oil for certain purposes.

The quantity of oil that may be obtained from the peanut will depend upon the variety, the maturity of the peas, and the apparatus with which the extraction is made. The Spanish meats when

shelled and thoroughly cleaned frequently contain as high as 45 per cent of oil, as shown by chemical analysis, although not more than 34 per cent can be expressed by the best of present methods and perhaps about 28 per cent by ordinary machinery. It is generally conceded that in order to make the manufacture of oil profitable good peanuts must be obtainable at prices not exceeding 75 cents a bushel. A bushel of first-class Spanish peanuts, weighing 30 pounds, will produce about 1 gallon of oil, worth about 75 cents, and 20 pounds of oil cake and hulls, which when ground and mixed together will be worth approximately 25 cents, or $25 a ton, as stock feed.

With a coming shortage of cottonseed from which to manufacture oil in this country there is a great possibility of building up a peanut-oil industry throughout the cotton belt of the Southern States. There are thousands of acres of land now lying idle that will produce fairly good crops of peanuts, and their growth will improve the land. By combining the use of cottonseed and peanuts for the production of oil it would be possible to keep the existing oil mills of the South running at a profit to both the farmer and mill owners. The oil that remains in the cake will not be lost, as there is demand for the cake for fertilizers and for stock feed. The process of expression is very similar to that for cottonseed oil and the greater portion of the machinery of the present oil mills is adapted to the manufacture of peanut oil.

Use of the Peanut on the Farm.—In sections where the soil and climate are suitable the peanut is rapidly becoming a crop of general farm importance. In the Southern States peanuts can be grown under a wide range of conditions, and the product can be used for several purposes. Peanuts are valuable as a substitute for cowpeas, especially on certain soils that are not adapted to the growing of the cowpea. In many sections where the clovers and other soil-renovating crops will not withstand the heat and drought of the summer months the peanut will thrive and make an excellent growth. A crop of peanuts for forage can often be grown after the removal of oats or some other spring crop, and although they may be badly overgrown by crab-grass, the tops may be mown with the grass for hay, and the hogs turned in to root out the peas.

Throughout Georgia and the surrounding Gulf Coast States the peanut is extensively used for planting in the alleys between the rows of corn. The peanuts are planted at the time the corn is given the last working, and are allowed to grow as a catch crop among the corn. After the corn is pulled, cattle are turned in to eat the fodder and the peanut tops. Following the cattle the land is pastured by hogs to clean up everything that remains. In this way most of the nitrogen stored by the peanut roots is left in the soil.

The Value of Peanut Hay for Feeding Purposes.—The tops of the peanut plant when cut and cured in the same manner as other legumes will produce a hay that is almost equal in feeding value to the best clover hay. By planting the Spanish peanut in rows from 24 to 30 inches apart and quite closely in the row and by giving the crop about two cultivations, it is possible to produce from one to two tons of hay to the acre. After the hay is removed the pods can be

turned out by means of a plow, cured, and stored for winter-feeding, or hogs may be turned in to gather the crop. The following table shows the comparative value of peanut hay:

Comparative analysis of peanut hay and other hays.

Dry matter.	Protein.	Carbohydrates.	Fats.
	Per cent.	*Per cent.*	*Per cent.*
Peanut hay	11.75	46.95	1.84
Peanut, entire plant	13.48	36.28	15.06
Clover hay	12.84	48.31	2.11
Timothy hay	7.17	52.94	1.97
Cowpea hay	19.72	45.15	4.04
Alfalfa hay	16.48	42.62	2.03

Peanut straw, consisting of the entire vine after the salable nuts have been removed, has a somewhat higher feeding value than the tops alone, due to the fact that many of the inferior pods are left in the straw. Peanut straw is, however, not so bright or palatable for feeding as are the peanut tops when cut and cured especially for hay.

Value of the Entire Peanut Plant as Forage.—Throughout that portion of the Southern States where field corn does not yield a satisfactory crop, the place of corn for feeding to animals may be largely taken by the peanut. On some ranches where a large number of work animals are maintained the Spanish peanut, including the entire plant, is practically the only feed used.

The peanut vines and peas when chopped or ground together form almost a balanced ration for a dairy cow. The following table will give some idea of the comparative value of peanut products and other feeding stuffs:

Comparative analysis of peanuts and other feeding materials.

Dry matter.	Protein.	Carbohydrates.	Fats.
	Per cent.	*Per cent.*	*Per cent.*
Ground corn and oats	9.6	71.9	4.4
Corn meal	9.2	68.7	3.8
Wheat bran	15.4	60.4	4.0
Cottonseed meal	42.3	23.6	13.1
Peanut kernels	26.6	16.7	42.0
Peanut vines	10.0	42.0	3.6
Clover hay	12.4	33.8	4.5
Alfalfa	14.3	42.7	2.2
Peanut, whole plant	13.5	36.2	15.0

Use of Peanuts for Fattening Hogs.—As already suggested, the peanut is a valuable feed for use in preparing hogs for market, the usual custom being to turn the hogs into the peanut fields and allow them to glean whatever is left after harvesting. In some sections peanuts are being grown primarily for feeding to hogs. Poorly filled nuts, broken peas, the germs, and waste products generally are fed

to hogs during the earlier part of the fattening period. A hog that is fattened exclusively on peanuts will not yield a desirable grade of meat or lard, as the meat will lack firmness and the lard be soft and oily. Toward the end of the fattening period the hog should be fed almost exclusively on corn. Hogs will eat considerable of the peanut tops when pastured on them, and the plan of dividing the field into small areas by portable fences and allowing the hogs to gather the peas is perhaps the most economical. A method that has been found very satisfactory is first to cut the peanut tops for hay, then turn in hogs. By turning the hogs into the field for a short time only each day, the injury to the soil will not be so great as if they were left in continuously.

Methods of Handling and Curing Peanuts for Forage.—Where the entire peanut plant is to be stored and used for feeding to stock the work of curing and caring for the vines should be very much the same as for market purposes, although the crop may be handled very much in the same manner as cowpeas. By experience it has been found most economical to harvest and stack the peanuts in exactly the same manner as already described for market purposes; however, the stacking may or may not be done so carefully.

Peanut vines if handled in the same way as vines of the cowpea yield a very desirable class of forage. Persons who have used the peanut exclusively for feeding purposes claim that they have had no difficulty in feeding it to all kinds of work animals, even driving horses. It is well, however, to feed only a part ration of peanut vines at first and to observe the animals until they become accustomed to this form of diet. Under ordinary circumstances the plant is fed without removing the nuts, but it may be well in some cases to pick the peanuts from the vines and grind them, shell and all, and then feed as a meal with the vines.—(F. B. 431; F. B. 356.)

(*Additional References.*—Ark. E. S. B. 84; Ariz. E. S. F. B. 87; Hawaii P. B. 28; Ark. E. S. Cir. 5; Tenn. E. S. B. 2; Miss. E. S. B. 130.)

GROWING AND CURING HOPS.

It is impossible to give a detailed account of methods of hop growing which will apply in all sections of the United States. The peculiar conditions of soil, climate, and location influence the prevailing methods of culture as well as the varieties grown and render it necessary for the practical grower to adopt those methods which, according to his experience, are best suited to his conditions.

CONDITIONS ESSENTIAL TO HOP GROWING.

Climate.—The hop plant can be grown generally throughout the United States, but at present its commercial production is practically restricted to areas situated in the States of Oregon, California, New York, and Washington. Small quantities are raised in Wisconsin, Idaho, Massachusetts, Pennsylvania, Michigan, Vermont, Kentucky, and Ohio. The industry has become sharply localized in districts which furnish the most favorable conditions. Long and severe winters frequently kill out many of the plants, and continued damp or foggy weather is usually followed by severe attacks of lice or mold.

While hops may be grown under very different climatic conditions, they are produced most successfully in the milder regions, where abundant early rainfall is followed by warm dry weather as the crop approaches maturity. In the Yakima Valley, Washington, where the rainfall is very scanty, irrigation is necessary. The hop plant readily adapts itself to very different conditions of rainfall, but when the harvest months—August and September—are accompanied by much rainfall the crop frequently suffers heavy damage from lice and mold.

Soil.—The selection of the best soil on which to grow the hop plant involves the consideration of several factors, depending on the peculiarities of the plant itself and the physical conditions of the region in which the land lies. In general, rich alluvial lands or deep sandy or gravelly loams are preferred for hop raising. The soil with a high percentage of sand is readily tillable, while the cultivation of a stiff soil is difficult and expensive. Owing to variations in the rainfall, amount of sunshine, and force of the prevailing winds, land suitable for hop culture in one region would be entirely unsuitable if located in another. Since the roots of the hop plant penetrate the earth for a distance of many feet, a well-drained subsoil is essential. Especial attention must be given to the depth, fertility, drainage, and fineness of the soil. Heavy wet soils are avoided and stiff clayey soils are in general disfavor.

PROPAGATION.

Propagation From Seed.—Hop plants may be raised from the seeds, but this method is seldom employed, since by using cuttings strong plants are more easily and quickly secured. Moreover, seedlings have a tendency to vary greatly, both as to the time of maturing the hops and the quality of the product. Yards planted with seedlings usually show little uniformity in the variety of hops produced and in the time of ripening. Except in certain localities, seedlings will not produce hops the first year, and even in the second year only a small yield may be expected.

Use of Cuttings.—The simplest method of growing hop vines is from root cuttings, also called roots or sets. In some localities roots that have been in the nursery for one year are called "sets." The numerous runners sent out by the hop plant just below the surface of the ground are removed when the plants are pruned in the spring, and these, cut into pieces each bearing at least two sets of "eyes" or buds, are used to produce new plants. In some sections of the Pacific coast a crop may be obtained from cuttings planted in the spring, but in general a full crop is not harvested until the second year.

The best cuttings are those taken from young plants, as they are more resistant to disease and should be more productive than those from old plants. All cuttings should be carefully inspected before planting and the diseased or damaged ones rejected.

Originating New Varieties.—The important subject of originating new varieties, as well as the no less promising one of improving existing varieties, merits the attention of every hop grower. The plants of every field are more or less variable. Some bear more

heavily than others, some are richer in the desirable resins, and some will show other high-grade qualities. New varieties may be sought for among the plants in the nursery when these are grown from seed. After the seedlings have been transplanted to the yards and have matured a crop a careful examination at picking time may show that some have superior qualities. These should be suitably marked and cuttings made therefrom the next season for further selection. There is no good reason why this method if persisted in should not produce valuable new varieties. The favorable results obtained with new and improved varieties of corn, wheat, grapes, and other crops may be duplicated in hop culture and suggest lines along which improvement may be made, particularly in regard to bettering the quality of the product.

Selection.—The opportunity for producing improved sorts by selection of the stocks from which cuttings are taken offers a promising field for the progressive hop grower. Many growers who give much attention to improving the fertility of their fields and their methods of cultivation take their cuttings for planting from the nearest available supply without any consideration of the productiveness, and other qualities of the plants from which the cuttings are taken. This has resulted in many yards in the loss of certain distinct varietal characteristics, and in almost every field mixed varieties and light and heavy producers occur indiscriminately.

A careful study of the productiveness of an acre of hops in California has recently shown that the yield of individual hills varied from a few ounces to 18 pounds of green hops. When the number of these low-yielding hills is large the total yield will be correspondingly reduced. Such hills should be removed and replaced by roots taken from plants giving high yields. In certain sections the hop plant is affected by a crown gall which is known locally as "root-knot" or "warts." A rigorous selection of new roots used is necessary not only to avoid setting out roots already diseased, but that roots may be obtained, if possible, which will be resistant to the attacks of the disease itself.

A decided improvement in quality should follow the careful selection of cuttings with reference to productiveness, uniformity, disease resistance, and general adaptability to the cultural conditions in the region where they are to be grown. The selection should be made at picking time, when the hills containing plants of superior quality and productiveness can be staked, so that cuttings may be taken therefrom the next season.

PLANTING AND CULTIVATING.

Time to Plant.—The time at which planting is done depends very largely on the local conditions existing where the crop is grown, but in general the best results are obtained by planting as soon as the soil can be worked into a fine mellow condition. In California planting should be done in January or February, although in some seasons planting as late as May 1 has yielded good results. In Oregon and Washington hops are planted in March or April, and in New York successful plantings have been made in April in favorable seasons.

Setting the Roots.—In California practically all new hops are now set out in rows at a distance of 6½ to 7 feet apart each way. When set 6½ feet apart, there will be 1,031 hills to the acre and 42¼ square feet of soil to the plants of each hill; when set 7 feet apart, there will be 889 hills per acre and 49 square feet of soil to the plants of each hill. In Oregon and Washington, where two horses are used in cultivating, the distance between rows is usually 8 feet, requiring but 680 plants per acre.

The methods of cultivating the hop yards necessitate straight rows. Three and often four cuttings are set in each hill. Differences of opinion and practice exist, and the number which it is advisable to set is in a measure dependent on the system of training employed and the cost of roots. The setting of a fourth root is a measure of precaution against the possibility of loss by rotting or injury of one or more of the cuttings after they are set out.

A good method of setting the roots is first to mark the center of each hill by a small stake, to which are to be attached the strings on which the vines are to run; then, about this stake to make three holes forming roughly the apexes of an equilateral triangle with a side measuring about 6 inches. These holes are usually made with a dibble, but in very compact soils an iron crowbar is frequently used. The roots are then placed singly in these holes in an upright position, with the buds pointing upward, at such a depth that they will be from 1 inch (in Oregon) to 3 inches (in California) below the surface of the soil, which is then slightly tamped about them. Another method is to make a hole with a spade at the location of the hill and to plant therein from one to four roots, according to their strength. This is the more rapid method but is less desirable, since the roots are crowded together and are more subject to decay. The price of roots is quite variable, ranging from $1 per 1,000 when they are plentiful to from $8 to $10 per 1,000 in years when they are scarce.

Cultivating.—Thorough cultivation is important and should begin early and continue until the plants are well armed out. This is necessary not only to keep down the weeds, but also to prevent the topsoil from forming a crust and becoming hard, for when it is in this state the moisture of the undersoil rises to the surface and evaporates quickly. The frequent stirring of the topsoil to a depth of 2 or 3 inches will produce a layer of finely divided soil which conserves the moisture near the surface, where it is more readily reached by the young feeding roots which develop at about the time the hops go into the burr. If these small feeding roots are destroyed or seriously injured by late cultivation, growth will be checked and early ripening favored. Careful growers agree that the young buds do not set so well if the feeding roots are seriously disturbed, and that the crop is shorter in consequence. Nevertheless, if the soil is becoming hard and the moisture is readily evaporating, it may be best, at least in dry sections, to cultivate and depend upon a second growth of the feeding roots for the proper maturing of the crop. The existing soil conditions must determine the advisability of cultivating after the appearance of the feeding roots.

Pruning.—By the process of pruning, the excess shoots from the rootstock are removed and the formation of fewer but at the same time stronger vines is favored. The rootstock itself also is reduced to an acceptable form and suitable depth below the surface of the soil, and the formation of undesirable runners is retarded or suppressed. The working over of the ground incident to pruning also is an important part of cultivation. Within certain limits determined by local conditions, the length of the growing period and the time of ripening may be influenced by the earliness or lateness of pruning. The general practice is to prune early in the spring, the exact time being determined by the season and the locality.

A common practice is to draw four or five furrows with a small plow on each side of the row, turning the earth away from the hills. The yard is then cross-plowed in a similar manner, leaving each hill a small undisturbed square. The earth is then hoed and grubbed away from the roots, and the superfluous roots and runners, together with an inch or two at the top of the root crown, are cut off with a sharp knife. After pruning, the hoe is used to pull the soil back upon the hill, covering the rootstock to a depth of 2 or 3 inches. Too much pruning by this method causes disease, and frequently uneven pruning causes the late coming out of the overpruned vines.

Another method which offers several advantages over the former is to prepare the ground by plowing as before, using a coulter on the plow in drawing the last two furrows. The hill is not dug into, but instead a sharp spade is used, with which each side of the hill is cut down on a slant from top to bottom, leaving the hill about 4 inches square at the top and 12 to 14 inches square at the bottom. With this method baking of the soil over the hill is avoided and the new shoots come through much more easily. The pruning is more even and the rootstock suffers less from wounds and bruises than by the former method.

The eyes or buds on the upper part of the rootstock begin to grow earlier in the spring than those on the lower portion. But the shoots from the lower eyes make a much more rapid growth; hence, it is desirable to remove the upper eyes in pruning. This fact is of special importance in regions subject to late frosts in spring. Care should be taken in pruning the root crown not to remove all of the new wood formed in the preceding summer, since the eyes on the old rootstock produce weaker shoots than those on the new wood. In pruning, each plant must receive individual treatment according to its condition and state of development. The number and strength of the vines produced after pruning afford the best means of judging the correctness of the pruning as well as the soundness and vigor of the rootstock.

The later development of the plant is much modified by pruning. Longer, stouter, and better developed vines, longer arms, and more abundant strobiles or cones result when the pruning has been properly done. In wild hops which have been pruned for several years it has been found that the form of the cones has been modified and the lupulin content increased. There is good reason to believe that if more attention was paid to the important process of pruning

a substantial increase both in the yield and quality of the hops produced would result.

Trellises.—Except in the hop-growing regions of New York, the use of hop poles has been largely discontinued in those regions where there is a scarcity of available timber, and even in heavily wooded sections many growers have dispensed with them. This is not due to the labor and expense of handling alone, but experience has proved that the advantages of growing hops on strings so far surpass the growth on poles that it is only a question of time when poles will be almost entirely abandoned. The hops are healthier on strings, more successfully sprayed, mature earlier, are usually richer and brighter, arm out lower, and are not so leafy; they do not wind-whip so readily, can be picked cleaner, and are much more easily torn down for picking. Also the hops can be picked without cutting the vine, a practice which is harmful, since it prevents the return of materials from the vine to the root of the hop, and, by causing a loss of food reserves to the stock, produces a weakening effect on the succeeding crop.

For a permanent yard some form of wire trellis will doubtless give the best satisfaction in most sections. In sections where timber is plentiful the first cost somewhat exceeds that of the pole system, but the saving in labor, the advantages afforded in spraying, and the heavier crop obtained by this method have uniformly reduced the cost of hop production where poles have been replaced by wire trellises.

The wire trellis is constructed in almost numberless ways, but these may all be included in two general classes or types—the high and the low trellis. The high trellis is most widely used, and upon it the greatest improvements have been made.

The High Trellis.—The high-wire system consists essentially in setting posts at every sixth or seventh hill throughout the yard. Over the tops of these posts wires are stretched across the yard each way at right angles. Posts are also set at the ends of the intervening rows, between which wires are stretched over the rows. These wires are fastened to the cross wires, and strings led up to them from the hills support the vines.

For posts, which may be either split or sawed timber, suitable hard wood or creosoted pine is used. These posts are usually from 4 to 6 inches in diameter and 20 feet long. The end posts should not be less than 6 by 6 inches, but somewhat lighter timbers may be used for interior supports. The posts are set from 1½ to 2 feet in the ground, the interior ones upright, those in the outside rows inclining somewhat outward. At a distance of about 14 feet outward from the foot of each end post an anchor, made of a piece of timber 6 by 6 inches and 4 feet long, is buried at a depth of 4 to 6 feet, according to the tenacity of the soil. Anchors made from locust are preferred, because of the lasting quality of the wood. A strong guy wire is run from the top of the post and fastened securely to the anchor; or the string wire may be run over the top of the end post and down to the anchor.

To permit easier access to the field, posts are frequently placed at the ends of alternate rows only. The string wires of the rows without end posts are then either run over the end cross wire to the ground and anchored or they are forked and fastened to the end posts on each side. For the principal or cross wires running across the field the shortest way and fastened on the top of each post with heavy staples No. 0 annealed iron wire is used. These wires are keyed up taut and fastened securely to anchors at each end. For the other or string wires Nos. 6 to 8 annealed iron wires may be used. On the latest improved or drop-wire trellis the string wires are held in place underneath the cross wire by short S-hooks made of No. 2 wire. At picking time the string wires may be unhooked and let down, thus bringing the hops within easy reach of the pickers. This trellis can usually be erected at a cost of $80 to $90 an acre, and twine for supporting the vines necessitates an annual expenditure of about $5 an acre.

In another successful form of this system an additional wire, known as the "breast wire," runs over each row below and parallel to the string wire at a height of about 6 feet from the ground. The strings rise vertically to the breast wire; then they are taken on the slope to the top or string wire, which is above the next row of hills. The angle of the sloping string is affected by the distance between the rows as well as by the height of the breast wire. The steeper the slope the better the growth of the vine. At half slope hand training will be necessary, but a flat slope gives better exposure to the sun and increases productiveness.

The Low Trellis.—The low form of trellis appears in several modifications. In one form poles about 8 feet long are set at each hill. Over the tops of the poles wires are run the full length of the yard each way, crossing at right angles. The vines are led up the poles or stakes and then find support on the wires. In many cases stout twine is used instead of wire, and in some instances the poles are set at every third hill.

Except in situations swept by strong winds, the high trellis is much more satisfactory. It is a permanent structure which gives easy access for teams to every part of the yard. The hops receive more uniform exposure to light and air and are in consequence better developed. Cultivation is not interfered with by drooping arms so much as in the low-trellis system. The hops can be readily sprayed even at picking time, when the worst attacks of lice are likely to occur. Since a hop vine will not follow a horizontal support, when it reaches the wire or string of the low trellis it must be trained by hand, thus materially increasing the cost of cultivation.

SYSTEMS OF TRAINING.

Stringing.—Where the high-wire trellis is employed, cotton cord is used to form supports for the vines until they reach the wires. The string consists of two portions knotted together; one, a cord 4 feet long having a breaking strain of 80 pounds, is attached to the wire, and the other, a cord 15 feet long having a breaking strain of 20 pounds, is tied to a small stake set in the hill. The smaller cord is strong enough to support the vine until it reaches the heavier cord

at the top. Good hemp is often used for the top string instead of cotton cord. The string may be fastened to the wires by means of a special knot-tying device attached to the end of a long pole, but the plan pursued in the trellis fields where the drop-wire system is used is simply to unhook and lower the string wire to which the strings may then be attached by the workmen while standing on the ground. The strings, which are cut to the desired lengths and knotted in advance, are fastened to the wires about 20 inches from a point on the wire directly over the center of each hill. Usually but two strings are used for each hill, and when all have been fastened to the wire it is again hooked up in place on the cross wires.

Another plan is to use a "trellis wagon," on which is a platform of such elevation that the workmen thereon may move about freely beneath the wires while attaching the strings. The wagon follows the string wire across the field. Two or three men on the wagon will put the strings on two wires as fast as the team can walk. Four men following the wagon can fasten the ends of the strings to small stakes set in the ground at each hill.

In the pole yards of New York a loop in one end of the string is passed over the top of the pole by means of a forked stick, and then drawn taut. The remaining end is then fastened to the adjacent pole in the next row about 5 feet from the ground. Frequently another string is fastened from pole to pole at the same distance above ground.

Training.—When the young vines are about 2 feet long training is begun. Usually the four runners most closely approaching in length the average of the field are selected from each hill and the remainder are cut off. In case of an uneven stand it may be well to cut off the whole field and wait for the second set of runners. However, vines which may be inferior at first sometimes develop a vigorous growth after they have reached a length of 4 or 5 feet. As a general rule, in all light producing sections it is advisable to train the first runners; in heavy producing sections the second runners should be chosen. Two runners are usually trained to each string, care being taken to twine them from left to right about the string.

It has been shown that under certain conditions the yield per hill is directly proportional to the number of vines trained. Except on very heavy cropping land better results should follow when six vines to each hill are trained than with a smaller number.

In the New York yards many farmers train seven vines up each pole, three for the long string and two each for the other string and the pole.

PICKING.

Time to Pick.—The time when hops should be picked varies with the locality, the season, and the variety cultivated. When the acreage is large there is a tendency to start picking before the crop is fully mature, as otherwise a portion may be lost through becoming overripe. Also a great consideration with many growers is the early engagement of pickers. To this end it is customary in some sections to plant an early-bearing variety, e. g., Fuggles, which ripens

from a week to ten days earlier than the other standard varieties and enables the grower to begin picking so much earlier.

A second consideration is the capacity of the drying plant to handle the crop as fast as harvested. If the acreage is large and the crop heavy, the facilities for handling and drying the hops will be taxed to their utmost, and if more hops are picked than can be put upon the kilns and dried without delay, they undergo heating, and are thereby seriously damaged in quality or lost entirely. Because of inadequate facilities, therefore, growers frequently begin picking before the hops are ripe and continue picking after they have passed what is recognized as the most suitable stage for harvesting.

A third consideration, which is recognized by all progressive growers, is the effect of the picking time upon the quality of the product. The development of the essential oil, the desirable soft resins, and other valuable constituents reaches its height about the time the hops become fully ripe, in which condition they are generally regarded as possessing the finest flavor.

From the standpoint of the consumer the time of picking is a matter of great interest, and it should be also to every grower, as a much higher quality of hops would result from picking at the proper time. However, for reasons previously mentioned it is often very difficult to secure pickers when the crop is just ripe. In addition to the difficulties just mentioned, the several parts of the field rarely ripen exactly together; often when a field is practically level slight variations in quality of soil or moisture content will result in unevenness in ripening, and while it is customary in picking to work around and through the field, choosing first the ripe portions, it is rarely possible to pick all of the crop at the most desirable degree of ripeness.

While growers recognize in a general way the importance of a proper picking time, the disadvantages arising from a disregard of this time are not appreciated by all. There are several important objections to improperly picked hops which reduce their market value.

Necessity for Clean Picking.—In picking every effort should be made to reduce to a minimum the quantity of leaves, stems, and other foreign material. The presence of leaves in cured hops renders them unsightly and materially reduces their market value. The opinion is frequently expressed by the more important hop dealers that one of the principal points for raising the quality of the American hop is clean picking.

Disadvantages of Unripe Hops.—Unripe hops contain more water in proportion to their weight of dry substance than those which are ripe; consequently in drying the "conversion" is not so high; that is, the ratio of the dry hops to the weight of green hops put upon the kiln is smaller when the hops are unripe. Unripe hops are also more difficult to dry on the kiln, probably because of their higher water content and tendency to pack together as soon as wilted, and they do not keep so well when stored. Since the lupulin in unripe hops has not reached its full development, there is an absolute loss of weight by picking in this condition. The aroma is not so

well developed and the amount of resins is smaller in the unripe hop. Not only is there a loss of weight due to too early picking, but practically all of the desirable qualities upon which the value of the hop depends are also in large measure diminished.

Tests for Ripe Hops.—By means of certain practical tests the degrees of ripeness and suitability for picking of the hop may be readily determined. (1) The strobiles or cones; which are bright green in color in the vegetative state, change gradually to a bright yellowish green as they approach ripeness. This is not always an exact test, as the color is somewhat dependent upon the soil and some other factors. Some hops have a greenish color when they are ripe. Sometimes in fields infested by the wild morning-glory a yellowing of the cones may occur, which is not due to ripening, but rather indicates an unhealthy condition in the plants themselves. (2) Immature hops are soft and pliable and have no resiliency or elasticity. As they ripen, however, they become more and more elastic, and if slightly compressed between the fingers will, on being released, assume at once their original condition. (3) When hops have a crisp feeling and give forth a rustling sound when crushed in the hand they are regarded as ripe. (4) The so-called seeds of the hop are in reality fruits, the seed being covered by a closely adhering pericarp, which, when the hop is ripe, takes on a dark purple color. At this time also the seeds fill out and become hard. (5) The bracts at the point of the cone close as ripening progresses, and the cones themselves feel sticky or greasy. (6) Immature hops have little odor aside from the natural green or plant odor until they are near ripeness, when the characteristic lupulin odor becomes very marked. (7) As the hops approach maturity the upper foliage leaves change from light green to dark green, while those on the lower part of the plant turn yellowish and drop off.

CURING.

Practical Drying.—The most important and at the same time the most difficult part of hop production is proper drying. No other factor affects the quality, appearance, and market value as much as the manner in which the hops are handled during the curing process. In the drying process three factors are of primary importance. These are (1) degree of temperature used; (2) length of time of drying; (3) volume of air passing through the hops. Also, in drying at a very low temperature the humidity of the air is an important factor. Only the first two of the factors mentioned have been generally recognized, and the high temperatures used at present are the result of shortening the time of drying. It is possible to diminish the temperature materially without lengthening the time of drying by forcing through the hops a large volume of air at low temperature.

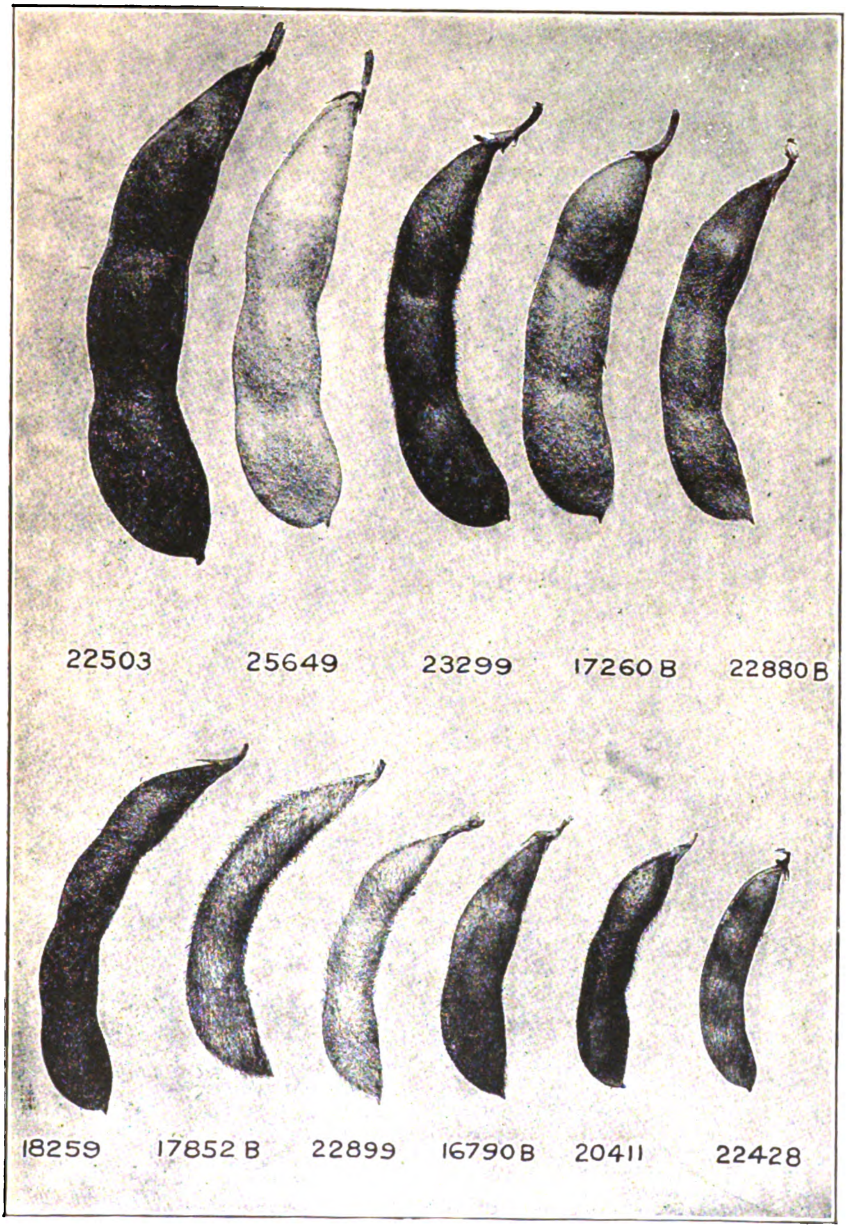
The first care is to properly lay the hops on the drying floor. They should be spread out evenly and loosely to a depth of 14 to 24 inches, depending upon the ripeness. In an uneven floor the heat will break through first in the thinner places, which quickly become dry, while the thicker portions remain damp. If the hops are trampled or otherwise packed together on the floor the heat will not

readily pass through them and drying is rendered uneven. Some practical growers set a stout wire screen of about 5-inch mesh at the desired height above the floor and the hops emptied from the bags upon this fall lightly and evenly to the floor beneath. The top is then carefully leveled with a rake.

As soon as the floor is laid the fires are started and the heat is gradually brought up to the desired point. In from three to five hours the hops will have become heated throughout and sufficient moisture will be driven off so that the hot air will readily pass through them. Until this point is reached the temperature must be closely watched, as too rapid firing at first will cause the under layers to scorch. In sections where drying is accomplished in ten to twelve hours a very common practice is to turn the hops with a wooden barley fork when the lower layers are dry enough to rattle when stirred. This should be done only when absolutely necessary, as turning breaks and shatters the hops and a portion of the lupulin is lost. Since the hops can not be turned evenly this practice hinders uniform drying.

During the course of drying sufficient ventilation must be provided to carry off the moisture without at the same time cooling the sides of the kiln and the top of the hops enough to cause the moisture to be deposited. Warming the air and the sides of the kiln above the hops materially aids drying. In the more northerly hop regions the most successful kilns are ceiled to the top, thus better retaining the heat.

The almost universal failure to recognize the harmful effects of high temperature in drying has caused wide diversity in practice. Temperatures of over 200° F. are not uncommon. That this is far too high has been shown by experiments made in the field with hops cured on various kilns at different temperatures. Aside from ruining the flavor by overdrying or scorching, there is a distinct loss of valuable essential principles by drying at high temperatures. The volatile oil, to which the aroma is largely due, is partly evaporated and the lupulin is rendered inferior, since the amount of the desirable soft resins becomes proportionately less as the drying temperature is increased. The best temperature for drying is yet to be determined, but every consideration indicates that it should be much lower than that commonly employed, probably between 100° and 140° F. Practical experience has shown that good drying may be accomplished with a temperature of 110° F., and the general trend of opinion is toward the use of the lower temperatures in drying. No fixed temperature, however, can be assigned as the most suitable for drying, because a degree of heat which at one stage of drying would probably be detrimental, at another would have no injurious effects. In taking the temperature care should be used to see that the thermometer is placed where the heat on the hops is greatest. This point has been found to be just below the drying floor. During the first part of the drying a thermometer below the cloth of the drying floor will register higher than one placed on the floor at the bottom of the hops, and one placed just above the hops will register 30° to 40° lower until drying is perhaps half finished or until the heat



Pods of Soy Beans, Showing the Range in Size and Shape.

(See pages [illegible].)

breaks through the hops. During this period of drying the heat is concentrated on the lower layers of hops, and here the greatest care is necessary to avoid injury. When the heat begins to break through the hops the upper thermometer will show a rapid rise of temperature, while the one below the floor will show a decline. From this point on to the end of the drying the two thermometers will show approximately the same degree of temperature.

As already stated, hops are frequently cured in from ten to twelve hours, but, other conditions being equal, a higher temperature must be used than when the time is extended to eighteen or twenty hours. The advantages of slower curing or curing at a lower temperature should be universally understood by hop growers. Even a moderately high temperature continued too long will damage the quality of the hops, the same as too high a temperature. In order that the hops may be dried at as low a temperature as can be made to do the work a strong draft is necessary during the drying to continuously carry off the moisture from the hops. There is no doubt that the principle of the air-blast kiln at present most satisfactorily meets these requirements.

No definite rule has yet been given for determining when hops are sufficiently dried. The condition in which they may be safely removed from the kilns can at present be told only by experience. The amount of drying will vary from day to day, being dependent upon weather conditions and the ripeness of the hops. In general, drying should continue until nearly all the stems or cores are shriveled, but are still soft and pliable. If overdried, the stems crumble and break readily, and the lupulin loses its bright, clear yellow appearance and turns brown. If hops are taken off the kilns slack or underdried they are very apt to heat, which turns the lupulin brown, and to develop a sour musty smell which makes them undesirable. If they are high dried or overdried they will break badly and become chaffy, and they also develop a burnt, peanutty odor.

The thin leaf-like portions of the hop usually become dry enough to break readily by the time the stems are dried sufficiently to make safe the removal of the hops from the kiln. This condition may be remedied by closing the ventilators half an hour before the drying is finished. This will also somewhat restore hops that have been overdried, as the further escape of moisture from the kilns is prevented, which then tends to equalize in the hops, soon softening and toughening them. Many careful dryers make a regular practice of gradually closing the ventilators as drying proceeds, and finish the kiln with them tightly closed. The same result may be indifferently accomplished by opening all the doors of the kiln and letting the hops cool for about an hour, as by this process they absorb moisture from the air and become less brittle.

Sulphuring.—The practice of sulphuring hops, which is now almost universal, is a response to the demands of the market chiefly for the pale yellowish-green grades. The use of sulphur not only gives the hops the desirable yellow color, but makes them more uniform in appearance, thus increasing their salability. Many dealers are guided more by color than by other qualities, and such dealers

have been known to rate unsulphured hops as inferior, while sulphured hops from the same field were classed as choice.

The use of sulphur improves the color by bleaching, injures the micro-organisms present, and retards the deterioration of certain of the desirable chemical constituents, thus improving the keeping quality, and, according to a widespread belief, accelerates the drying. The sulphur is usually burned beneath the kiln floor at the commencement of drying. The usual practice is to use from 1 to 4 pounds of sulphur for each 100 pounds of undried hops. The action of the sulphur is most energetic while the hops are yet fresh and damp. Only refined sulphur of guaranteed purity should be used, as the crude sort usually contains impurities which may injure the quality of the hops. Certain of these impurities will become concentrated in the lower layers of hops on the kiln floor, and after these hops are baled some bales may show an unusually high percentage of these impurities. The best results are obtained with what is known commercially as rock sulphur. Roll sulphur differs from this only in the form in which it is cast and has no greater bleaching power.

MARKETING.

The most serious problem confronting the hop grower is how to market his product at a figure which will give a fair return for investment and labor. Owing in part to great fluctuations in prices, hop growing from a business point of view is extremely variable and uncertain. The state of the market is determined largely by the stock of hops held in storage from the previous year, by the crop conditions at home and abroad during the current year, and by the probable demand as judged from a comparison of the two conditions just mentioned. While the state of the market is conditioned by these three factors, it is influenced heavily by the dealers, hop merchants, or middlemen who stand between grower and consumer.

Only a small percentage of hop growers sell direct to consumers, so the bulk of the trade passes through the hands of middlemen. Sales may be made to the large dealer direct through his buyers or to the local dealer, who in turn sells to the large dealer; or growers may sell through a commission merchant who may act as agent for both grower and consumer. The broker, or factor, serves as a go-between for dealers or for dealer and consumer. All these middlemen occupy a recognized legitimate place in the trade so long as they confine their operations to buying and selling at market prices as fixed by supply and demand and depend for their profits upon the favorable terms which they may be able to make in the regular course of trading. Under existing conditions the hop crop could not be marketed without the middlemen. Growers with small holdings remote from consumers could scarcely find a market for their product even if the difficulties involved in arranging credit were overcome. The grower is usually in need of money and demands immediate payment; on the other hand, the consumer may not have funds available to pay cash for his hops at the time when it is necessary to make the purchase. The dealer solves the difficulty by relieving the grower of his stock and making cash payment therefor or a suitable

short-time arrangement and by selling to the consumer on terms to suit his convenience.

Although much significance is commonly attached to the locality in which the hops are produced, it is apparent that too much emphasis is laid on geographical origin as a standard of quality. It has been repeatedly demonstrated that dealers and consumers can not tell with certainty the section of the country a sample comes from by examination alone. Even samples from the same yard, when the conditions of drying have differed somewhat, have been ascribed to widely different sections by expert judges of hops.

The price which a consumer will pay for hops depends largely on their origin, thus making it frequently possible to deliver hops grown in one section when the sale was made on hops from another which commanded a different price. Unfortunately, there is no definite standard of quality in judging hops, and there is apparently too much importance attached to origin alone. While geographic origin may be of some importance, its usefulness as a standard of quality is small compared with the tests usually applied in judging the value of hops. In determining the relative quality of different lots of hops a fixed standard of valuation founded on intrinsic qualities rather than preference would be exceedingly valuable to both producer and consumer.

The present unsatisfactory conditions of marketing offer opportunities for improvement along several lines. One of the greatest needs of the hop industry is more complete and accessible statistics of production and consumption, not only that growers may govern their acreage by the prospective demand, but that, by knowing the amount consumed during the current year, the stocks remaining in the hands of consumers, and the crop conditions at home and abroad, an intelligent opinion may be formed as to the probable relation between supply and demand and what prices may therefore be reasonably expected. From the returns made by the officers of the Internal Revenue Service a quarterly statement would show the total amount of hops consumed, and from the consumption—its increase or decrease—the market possibilities could be inferred. Also the necessity is very great for frequent reliable statements of European crop conditions. The hop market is controlled by the production in the United States, England, Germany, and Austria; and, since the surplus production of the United States is exported almost entirely to England, crop conditions abroad practically control American prices. More reliable and detailed statistics of home production are needed. So many exaggerated reports are circulated for the purpose of influencing the market that an exact census of the acreage set out, the acreage harvested, and the number of bales produced would be of incalculable benefit to the producer; and this end would be much furthered by thorough cooperation on the part of the hop growers themselves.

On the Pacific coast several hop growers' associations have been organized along similar lines and with the same general purpose as the citrus growers' associations and others in Southern California. Other organizations modeled along the lines of the hop growers'

associations or cooperative unions of Europe should enable growers to protect their interests better and to secure recognition unobtainable as individuals. The industry is so centralized in the various States that a very small number of associations could easily include practically all the growers in their membership. With proper cooperation on the part of the members of the associations and the abandonment of the attitude of suspicion and distrust which too often characterizes the relations of producers with each other, it should be possible for growers to secure the adequate collection and distribution of the most necessary statistics of production and consumption and to more fully acquaint themselves with the need of better methods and of greater facilities for handling the business.—(F. B. 304.)

(Additional References: U. S. Div. of Bot. Cir. 19; B. P. I. Cir. 33, 56; Bu. Stat. B. 50; Nev. E. S. B. 35.)

MUSHROOMS.*

The fully expanded plant, or mature mushroom (sporophore), of *Agaricus campestris* is well known to everyone. It consists of a centrally placed stalk or stipe of from 2 to 6 inches in height, usually not more than 1 inch in diameter, and on the end of this stipe there is borne an umbrella-shaped or cap-shaped portion known as the cap or pileus. The diameter and thickness of this pileus vary greatly in different races or varieties of the cultivated form, and also with the conditions of the environment under which it is produced. The general color of the plant varies in the different varieties from an almost pure white, or cream, to the forms which are deep brown, at least with reference to the upper surface of the cap. The stem is usually cream or white, and bears on its upper extremity near the cap a ring known as the annulus, which annulus forms a covering and a protecting layer for the delicate under surface of the cap, to the edges of which it was attached previous to the rapid expansion and maturity of the latter. The under surface of the cap is provided with leaflike or gill-like projections, reaching for the most part from the stem to the periphery of the cap. These are termed gills, or "lamellæ." They are constantly pink in color in the white or cream-colored species up to the time of (and sometimes even a day after) the separation of the ring from the cap. Subsequently these gills turn brown and even a deep brownish black. In the brown variety the gills are at first grayish brown, but they also become almost black with age.—(F. B. 204.)

Differences in Mushrooms.—The differences between the common edible mushroom and the fly agaric and deadly agaric are as follows: (1) The common mushroom has a pileus which is not covered with wart-like scales; gills which are brownish purple when mature; a nearly cylindrical stalk, which is not hollow, with a ring near the middle, and without a bulbous base sheathed by a membrane or by scales. (2) The fly agaric has a pileus marked with prominent warts; gills always white; a stalk, with a large ring around the upper part, and hollow or cottony inside, but solid at the base, where it is bulbous and scaly. (3) The deadly agaric has a pileus without distinct warts; gills which are always white, and a

* For illustration, see page 663.

hollow stalk, with a large ring, and a prominent bulb at the base, whose upper margin is membranous or bag-like. (4) Other minor points of difference are the different places in which these species grow, and also the colors, which, although they vary in each case, are brilliant yellow or red in the fly agaric, white varying to pale olive in the deadly agaric, and white usually tinged with a little brown in the mushroom. (5) A word should be said as to the size and proportions of the pileus and stalk in these three species. In the mushroom the pileus averages from 3 to 4 inches in breadth, and the stalk is generally shorter than the breadth of the pileus and comparatively stout. The pileus remains convex for a long time, and does not become quite flat-topped until old. The substance is firm and solid. In the fly agaric the pileus, at first oval and convex, soon becomes flat and attains a breadth of 6 to 8 inches and sometimes more. The stalk has a length equal to or slightly exceeding the breadth of the pileus, and is comparatively slenderer than in the common mushroom, but nevertheless rather stout. The substance is less firm than in the common mushroom. (6) The pileus of the deadly agaric is thinner than that of the common mushroom, and, from being rather bell-shaped when young, becomes gradually flat-topped with the center a little raised. In breadth it is intermediate between the two preceding species. The stalk usually is longer than the breadth of the pileus, and the habit is slenderer than in the two preceding species. All three species are pleasant to the taste, which shows that one can not infer that a species is not poisonous because the taste is agreeable. The fly agaric has scarcely any odor. The other two species have certain odors of their own, but they can not be described.—(Y. B. 1897.)

Rules for Gathering Mushrooms.—The different popular tests for distinguishing edible from poisonous fungi, such as, for instance, the blackening of a silver coin or spoon when placed in a mass of poisonous fungi while they are being cooked, are all absolutely worthless. There is no test which can be applied, nor should reliance be placed, at least by the beginner, upon the fact that in some cases the poisonous substances may be removed by cooking in milk or vinegar. In such cases the danger may be only increased unless care is taken to remove all the vinegar or milk, and, in general, common sense warns us not to eat any fungus supposed to contain an active poison which requires to be removed by special treatment. The eating of such species should be left to the scientific experimenter. On the other hand, it need not be assumed that a fungus is poisonous when it is merely indigestible in consequence of the way in which it is cooked.

It is beyond the province of this article to discuss the nature of the poison of different fungi, but it should be said in general that the poisonous effects are of two kinds: The irritant, which affect the stomach and digestive organs directly, and show their effects soon after eating; and the narcotic, much more dangerous, which act upon the nervous centers and do not produce poisonous symptoms until after a number of hours, usually eight or ten. The

irritant fungi are often recognizable by their taste when raw, but the narcotic species are generally pleasant to the taste, or at least not disagreeable.

The following rules should not be neglected by the beginner: (1) Avoid fungi when in the button or unexpanded stage; also those in which the flesh has begun to decay, even if only slightly. (2) Avoid all fungi which have stalks with a swollen base surrounded by a sac-like or scaly envelope, especialy if the gills are white. (3) Avoid fungi having a milky juice, unless the milk is reddish. (4) Avoid fungi in which the cap, or pileus, is thin in proportion to the gills, and in which the gills are nearly all of equal length, especially if the pileus is bright colored. (5) Avoid all tube-bearing fungi in which the flesh changes color when cut or broken or where the mouths of the tubes are reddish, and in the case of other tube-bearing fungi experiment with caution. (6) Fungi which have a sort of spider web or flocculent ring around the upper part of the stalk should in general be avoided. Rules 1, 2, and 5 may for the beginner be regarded as absolute, with the exception of rule 2, *Amanita cæsarea,* the gills of which are yellow. Rules 3, 4, and 6 have more numerous exceptions, but these rules should be followed in all cases, unless the collector is content to experiment first with very small quantities and learn the practical result—(Y. B. 1897.)

Commercial Mushroom Growing.—Unusual interest has been shown in the United States in the growth of mushrooms within the past few years, and it is expected that the industry will develop to the fullest limit of the market demands. The latter will, of course, be stimulated and developed by the increasing popular appreciation of this product. In some cities and towns there is already a good market demand for mushrooms, while in others they may be sold only directly to special customers. This should be borne in mind by prospective growers.

Causes of Failure.—Success in mushroom growing depends on intelligent study of conditions and on experience. While many American growers have been successful in the production of mushrooms, a much larger number have failed. In most cases their failures have been due to one or more of the following causes: (1) The use of poor spawn, or of spawn which has been killed by improper storage. (2) Spawning at a temperature injuriously high. (3) The use of too much water either at the time of spawning or later. (4) Unfavorable temperature during the growing period. It is therefore important to the prospective grower that careful attention be given to the general discussion of conditions which follows.

Temperature and Moisture.—Mushrooms may be grown in any place where the conditions of temperature and moisture are favorable. A shed, cellar, cave, or vacant space in a greenhouse may be utilized to advantage for this purpose. The most essential factor, perhaps, is that of temperature. The proper temperature ranges from 53° to 60° F., with the best from 55° to 58° F. It is

unsafe to attempt to grow mushrooms on a commercial basis, according to present knowledge of the subject, at a temperature much less than 50° or greater than 63° F. Any severe changes of temperature retard growth, or else act injuriously, and many changes of temperature would entirely destroy the profits of the mushroom crop. From this it is evident that in many places mushrooms may not be grown as a summer crop. With artificial heat they may be grown almost anywhere throughout the winter. Moreover, it is very probable that in this country open-air culture must be limited to a few sections, and restricted, commercially at least, to a single season.

A second important factor is that of moisture. The place should not be very damp, or constantly dripping with water. Under such conditions successful commercial work is not possible. A place where it is possible to maintain a fairly moist condition of the atmosphere, and having such capability for ventilation as will cause at least a gradual evaporation, is, by general practice and by the most extensive experimentation, shown to be necessary. With too rapid ventilation and the consequent necessity of repeated applications of water to the mushroom bed no mushroom crop will attain the highest perfection.

Caves, Cellars, and Houses.—They are used for growing mushrooms, because in such places only can the conditions of temperature and moisture be best regulated. Cold is less injurious to mushroom beds than heat. The former renders the bed for a time unproductive; but the latter stimulates the spawn to too rapid growth, which is usually followed by the production of unsalable mushrooms, or by the eventual death of the spawn, supposedly by damping off.

Mushrooms may often be grown in a very simply constructed shed or unused barn which will provide against any sudden changes of the temperature, and when it is possible to employ artificial heat the season for mushroom production in such structures may be greatly extended. Cellars are very commonly used in producing mushrooms for family use. Natural or artificial caves are of the first importance, however, for commercial work, since the situation of these below the surface will best insure a temperature throughout almost the entire year more or less close to that which is desired. In selecting caves or cellars, one should guard against the possibility of flooding or of too much seepage water during a rainy season. Perhaps the least satisfactory situation among those mentioned is the greenhouse. Under ordinary circumstances it heats up too readily during days of warm sunshine, and, unless special precautions are taken, it is not to be generally recommended for amateurs. Nevertheless, during the fall and winter it is possible to grow mushrooms under the benches or in any other unused space with but very little outlay of money or labor. Cold frames may also be used to good advantage during the autumn or spring. The natural caves of this country and abandoned coal mines in some sections should be further investigated with relations to their adap-

tibility for the commercial production of mushrooms. A thorough study should also be made of open air conditions. In the construction of special mushroom houses any one of a variety of plans may be followed, and the selection of the style will depend, of course, upon its cheapness and efficiency in the particular locality.

Preparation of the Manure.—It should be borne in mind that while there are many methods leading to failure there are a number leading to success. In fact, persons succeed in mushroom growing by methods which seem absolutely different. It is essential that the physiological conditions of growth be understood, and then good judgment must be depended upon.

In the growing of mushrooms for commercial purposes, the beds should be constructed of stable manure which has been fermented or composted. Many experiments have been made looking toward the substitution of other composts or waste products for stable manure, but nothing has yet been found which may be more highly recommended. Fresh manure should be obtained, and this should include the litter used for bedding the animals, unless the latter consists of coarse weeds. It is a great mistake, in a commercial way, to attempt to use manure free from straw. Again, stable manure which has been well trampled is nearly always well preserved, and is frequently much richer than any other kind.

The manure should be piled in heaps about 3 feet deep when well pressed down with the fork, and these piles may be of considerable extent. It should be watered until well moistened throughout, but not drenched. In the course of four or five days or a week it will be necessary to fork over or "turn" the manure. A second turning will be required usually in from seven to ten days, and it may be necessary to water again if the material used has suffered considerable drying out. If well pressed down and merely moist, the manure will not burn and, moreover, there will be no tendency for a sour fermentation to become established. In from fifteen to twenty-one days, depending upon the conditions, the temperature will begin to fall, the violence of decomposition will begin to show a subsidence, and the compost will be ready for the construction of the beds. The bacteria of rapid decay will become less and less abundant, and finally, when the beds are prepared as subsequently described, the spawn will be able to grow in spite of the bacteria present.

It is the custom with some growers to mix a small quantity of loam, about one-fourth, with the manure. This enables one to use the manure earlier; and, indeed, under such circumstances it may sometimes be used with but little or no composting. Nevertheless, the majority of growers have obtained greater success by the use of the manure alone. Very well rotted compost should not be used in mushroom growing if large and solid mushrooms are desired. When sawdust or shavings are employed for bedding the animals, the composting may require a somewhat longer period.

The manure is always ready for the construction of beds when the above conditions have been fulfilled, or when nearly all objec-

tionable odors are lost and a sweet fermentation, as growers term it, has begun.

Preparing the Beds.—Mushroom beds are of two general types, (1) the flat bed, frequently referred to as the English, and (2) the ridge bed, known as the French type. In making the former the entire floor space may be utilized as a bed, and the beds may be arranged in the form of tiers or shelves. In low cellars or caves, and, indeed, wherever the amount of floor space is not the most important consideration, it would be well to avoid the use of shelves; but where the amount of floor space is an important factor they may be adopted to advantage, although the additional labor involved in the growing of a crop under such conditions is an item to be considered. When shelves are used one should be careful to whitewash these after each crop in order to avoid the increased danger from insect depredations. In any case, flat beds should be made from 8 to 10 inches deep. Ridge beds enable one to get a somewhat greater surface space in a given area, but they are also more expensive so far as the labor of construction is concerned. Nevertheless, under many circumstances they are obviously desirable. They should be about 2 feet wide at the base, tapering gradually to the apex, and not more than about 18 to 20 inches high when compressed and cased. The custom is to make two such beds in contact, and then to leave a walk way of 8 or 10 inches between the next two, and so on till the space is occupied. Next to the walls slanting beds may be prepared.

In any case, the manure is made up in the form of the bed desired, and should be firmed or compressed to some extent immediately, in order to prevent drying out and burning when the secondary fermentation takes place. At this time the manure should be neither wet nor dry, but merely moist. The only practical test of the proper moisture content of the manure which can be relied upon is when upon compression water can not readily be squeezed out of it.

Spawning.—After the beds are prepared the temperature should be, and it usually will be, too high for spawning. After a sudden rise the temperature should gradually fall during the course of a week or more to about 70° to 75° F. At this temperature spawning may take place, but under absolutely no circumstances should a bed be spawned at a temperature greater than 80° F. If brick spawn is used, the bricks are broken into pieces about 2 inches square, or into from 10 to 12 pieces per brick. These pieces are inserted from 1 to 2 inches below the surface, about 10 inches to 1 foot apart, and the bed is then compressed into final shape. Under the most favorable circumstances it is unnecessary and undesirable to water the beds for several weeks after spawning, or until they are loamed or cased. If they dry out rapidly and some water is necessary, it should be given as a surface spraying, for water in quantity applied to the young spawn will almost invariably cause the latter to damp off.

Casing the Beds.—An examination of the bed about two weeks after spawning is desirable, and if it is found that the spawn is "running" the beds may be cased with loam. Casing consists in applying a layer of loam from 1 to 1½ inches deep to the surface of the bed. This loam should have been secured some time in advance and carefully worked over or screened to get rid of the largest pebbles, lumps, and trash. When applied it should be barely moist. Subsequently, if watered at all, it should be merely sprinkled in order to prevent any drying out of the bed. Neither a heavy clay nor a sandy loam should be used for casing purposes, but almost any other soil is good.

Watering.—As previously indicated, the spreading spawn should receive no water, or, at least, as little as possible. When, however, the mushrooms begin to appear, more water will be required, and a light sprinkling may be given once or twice each week or as often as the conditions demand. Beds which come into bearing in proper condition should never be drenched. It has been found by experience that under the most favorable conditions a bed will require occasional sprinkling, since, owing to continual evaporation, there will be a gradual loss of water, at least after the mushrooms begin to appear. Sprinklings should be made after the mushrooms have been gathered, and the loam disturbed by the removal of mushrooms should always receive a light sprinkling.

Picking and Preparing for Market.—When a bed is in full bearing, the mushrooms should be gathered at least once in two days, and it is well to pick them every day, particularly if the temperature is up to 60°F. or more. Picking is itself an art, and the intelligent grower will soon find that the yield of a bed may be greatly lessened by lack of judgment in picking. To satisfy the general demands of the markets it is not recommended to take the buttons; yet if there is a fancy trade for these it should be met. Little or no gain of weight occurs in the mushroom, however, after the veil begins to break, so that mushrooms should not be left after this time. Flat tops are a third-grade article, but these, as well as all defective mushrooms, should be sedulously removed from the bed every day.

In picking, grasp the mushroom by the cap (a large one by both cap and stem), twisting it to remove it easily from the soil. Where the mushrooms come up in large united clusters, it will be best to cut them, in order not to disturb the mycelial connections of all. Some good growers practice "cutting" throughout, but the stubs must decay and are a source of danger. After all good mushrooms from a cluster have been taken, remove any fleshy spawn masses adhering and add fresh loam.

As they are picked, the mushrooms are put into shallow baskets and taken to a sorting and packing table. The stems are cut off and any adhering loam is brushed from the cap. It is true that mushrooms keep somewhat better if the stub is left attached and the loam removed by rubbing, but except in special cases this procedure is not to be recommended. It is not necessary to cut the stem

off short, but the market demands that there shall be few long shanks.

For the best trade it is desirable to "sort" the mushrooms, placing only those of nearly the same size in the same packages. It is certainly not well to pack together "broilers" and buttons, if this can be avoided. Defective mushrooms should invariably be thrown out. Mushrooms should be treated as a first-grade product in every way, and therefore the package must be attractive. If the time involved in shipment is not to be very long, they may be put into 5-pound splintwood baskets, or they may be packed in 2-pound boxes arranged in crates as prepared for fruit. Shipment may also be made in boxes of sizes demanded by the general or private trade. Baskets afford excellent ventilation, yet boxes are often to be preferred. If the latter are lined with a blue paraffin or oiled paper, a good color contrast will result and the package will be made much more attractive.

Market Prices.—The prices paid for mushrooms in American markets are unusually variable. Perhaps it is fair to say that one should consider from 35 to 50 cents per pound a good average price. In many cities or towns 30 cents would be as much as could be obtained. On the other hand, a price of 75 cents is frequently paid. The unusual quotation of one dollar or more is not to be expected. It is true that for a fine grade of mushrooms such prices are paid to retailers by the fancy trade and during special seasons or for special occasions. The grower may well look for the time, however, when the market demands will support a generous supply at a constant but fair price.

The Period of Production.—Under favorable circumstances, a bed may come into bearing within six weeks. It usually requires, however, a longer period, and eight weeks may more nearly represent the average conditions. If the conditions have been variable, and especially if at times a very low temperature has prevailed, bearing may be still further delayed. Again, the period of production or the profitable "life" of a successful bed may vary greatly, ranging from five weeks to as many months. As a rule, a bed which produces fine heavy mushrooms will bear longer than one which yields plants of lighter weight. Many growers think that there is a profit in a bed which yields one-half pound per square foot of surface area. One should not be satisfied with less than this, and if the best conditions prevail this yield is far below what should be obtained.

Old Beds.—When a bed has ceased to bear, or is no longer profitable commercially, it should be taken down and every particle of the bedding and casing materials removed from the cave, cellar, or house. The manure is still valuable for field and garden purposes, but it is wholly useless and even dangerous for mushrooms because it is not only exhausted with reference to mushroom growing but may also harbor the diseases or enemies of the mushroom. When the bed is removed the house should be thoroughly cleaned, and, if possible, sprayed or fumigated. If condi-

tions remain constant there is then no reason why another crop should not follow immediately.

Virgin Spawn.—Whether the spawn is made as bricks or as flake material, the point of greatest importance is to secure a so-called virgin spawn, or a new growth of the mycelium of *Agaricus campestris,* which has never exhausted itself to any degree by the production of mushrooms. The problem of securing such virgin spawn is a difficult one, and as usually met in England and France it leaves to chance the quality and other characters of the mushrooms which may grow from such spawn. If, accidentally, mushrooms are found growing on the lawns or in pastures, or if mycelium is located in such situations, small trenches are dug beneath the sod and these are filled with rich manure, with the hope that the vigorous-growing mycelium will penetrate this manure in the course of a few weeks. This usually occurs, and the spawn is said to be very good when one prevents the production of mushrooms by this spawn, and, if possible, by any of the mycelium in the vicinity. When the manure in the trenches is well penetrated by the mycelium, the spawn is removed and dried, and it is usually termed virgin spawn. It may then be used in the inoculation of spawn bricks or it may be used in the inoculation of small beds, either of which, when penetrated by the growing, mycelium, may in turn be used as commercial spawn, brick or flake, respectively, which is then sold or used in a commercial way.—(F. B. 204.)

(*Additional References.*—B. P. I. B. 85; Cornell E. S. B. 138, 168, 227; N. C. E. S. B. 132; Colo. E. S. Cir. 6; Idaho E. S. B. 27; Ind. E. S. B. 98; U. S. Div. of Bot. Cir. 13; Mich. E. S. B. 208; N. H. E. S. B. 59.)

THE CASTOR BEAN.

The Castor bean is of the botanical order *Euphorbiaceae* which also includes many well known cultivated plants, such as the potato, tomato and tobacco. There are many cultural varieties, some of which have been described as separate species, but all intergrade, so that lines of separation between forms can scarcely be distinguished. It is generally considered that all of the different forms or varieties, both wild and cultivated, are derivatives from the single species *Ricinus communis.*

Varieties.—There are two primary races of the castor bean; one a perennial bushy plant with large seeds, and one with small seeds. The former yields in considerable quantity an inferior oil employed only for illumination and lubrication, or in the various manufactures. The small seeded variety yields a superior oil, the qualities of which constitute it the medicinal oil of commerce.

This plant grows through a very wide range of climates, from the tropics to the north temperature zone, and varies in its size and habit of growth, from a perennial tree thirty or more feet in height, to an annual maturing seed in a very short season and growing only three or four feet in height.—(Hawaii E. S. B. 2.)

Cultivation and Harvesting.—The castor bean thrives in the sandiest soil, and its culture is very simple. The seeds germinate

with difficulty, owing to their thick and impervious coat; hence nearly boiling water should be poured over them before sowing, and they should remain in this for about twenty-four hours, the temperature of the water in the meantime gradually lowering to that of the atmosphere. They should be planted in hills, 2 inches deep, 8 or 10 seeds to a hill, and afterwards thinned out to 1, or at most 2, plants per hill. The rows are 5 or 6 feet apart, with the hills 2 or 3 feet distant. Between every sixth and seventh row should be left a space of about 8 feet, to permit the passage of a horse and wagon when the beans are harvested. In the South, where the castor bean grows more vigorously, the hills may be 6 or 7 feet apart. Planting should take place as early in the spring as possible, making allowance for frosts, to which the Ricinus is very susceptible. The cutworm, too, is sometimes a serious obstacle to its cultivation. The land should be kept free from weeds and the crop grown much the same as corn or beans, and on very similar soil.

In harvesting, the fruiting branches should be cut off as soon as the pods begin to pop open, which is in July in the South. This process must be repeated at least once or twice a week, as fast as the seeds ripen. The fruits are then spread out to dry, either on the floor of a granary or other close room or in a "dry yard" built near the castor-bean fields. This yard is made by cutting away the sod, rolling the ground hard, and building a tight board fence around it to prevent loss from the beans scattering. It is better to make a tight board floor for the dry yard, which should be in a sunny place, sloping to the south. The spikes must be turned over occasionally and kept protected from moisture. After the seeds have popped out they are cleaned from the shells with a common fanning mill.

In Florida and other warm countries the castor bean is a perennial plant, growing from 15 to 30 feet high and as large around as a man's body. In colder climates it behaves as an annual, dying down upon the approach of winter. The seeds are produced in great abundance, and their tendency to scatter when ripe renders the plant a great pest where it grows wild.—(Y. B. 1895.)

The castor oil plant is cultivated on a commercial scale principally in India. It is also largely cultivated in tropical Africa, Italy, Central and South American, China, and in the United States in Kansas, Oklahoma, Wisconsin, Oregon and California.

Uses of the Oil.—Castor oil has many uses. It is used in dyeing with various colors by calico printers; for dressing tanned hides and skins; for the manufacture of Morocco leather; for the preservation of harness; for the manufacture of varnish; and, in India, for illumination. It is one of the best lubricating oils for all classes of machinery; is employed for the manufacture of soaps, candles, pomatums, perfumed oils, golden oil, and in fact in a great variety of ways. The stems have been used for the manufacture of paper and charcoal. Indian authorities consider the oil far superior to petroleum or any other mineral oil, or to any vegetable oil, as an illuminant, as it burns with a white light of great brilliancy, without smoke or soot.

The pomace, or cake, remaining after the extraction of the oil from the kernels, is valuable as a fertilizer, and has also been used for the manufacture of an illuminating gas; it is also sometimes used as fuel. New uses are constantly being found for both the oil and the pomace, so that the market is ever ready to absorb whatever quantities of these products may be offered.

Conclusion.—The castor bean is a crop of some promise for cultivation by men of small means and although the yields per acre are moderate, perhaps seldom exceeding $75 to $80 gross income per annum and sometimes not exceeding half of that, the castor bean is a readily salable article, if not in the local markets, always in those of San Francisco, or other large markets.

It is a crop which up to the present time has very few enemies in this country, and a particular advantage is that the product does not readily deteriorate if properly cared for after harvesting. With average yields of from two thousand to three thousand pounds per acre, and with a crop which does not require replanting, except after a period of from five to seven years, the outlook is a very promising one.

While the cultivation of this crop is not one which would pay investments of large amounts of capital, yet it seems to be well suited to small land holders, who can use their own labor, or that of their families, and do not have to employ additional help.—(Hawaii E. S. B. 2; Okla. E. S. B. 54.)

CANAIGRE.

Canaigre (*Rumex hymenosepalus*) is a plant characterized by the high percentage of tannic acid contained in its roots. The leaves are said to have been used to some extent by the Indians as food, while the roots were used by them as medicine, and in a crude way for tanning hides and skins. The roots are at present being used in the preparation of tannic acid, dyes, and mordants, but their most important use is as a tanning agent. A tanning is any substance that will unite with the gelatin of raw hides and convert the dried skin into an insoluble, imputrescible, tough and flexible condition called leather.

Canaigre is a species of yellow dock, sometimes called wild rhubarb. It has large, smooth, dark green leaves. In the spring an erect succulent flower stem appears, which is two feet high or less. Where the plant has grown without water, the stem seldom appears. Where it is given water in abundance, it is frequently more than two feet high.

The roots form themselves in clusters around the parent root. When young they somewhat resemble sweet potatoes or dahlia tubers, but as they grow older they are much harder and darker in color. Thin transverse sections of the roots show concentric rings which are said to be annual rings of growth. The number of rings will give approximately, if not accurately, the age of the root. Its drought resisting power and its adaptation to long and comparatively mild winters, make the semi-arid southwest, its natural home.

It has been planted in Kansas, New York, North Carolina, Florida, and other states, but while it is reported to have lived and withstood the severe winters of the North, the roots made a very slow growth. In Florida and eastern Texas it is reported to have been grown with success. Canaigre may be propagated in three ways; first, from the seed; second, from the roots; third, from the transplanting of young shoots.—(N. Mex. E. S. B. 49.)

Seeding is best accomplished by means of young roots. These are quicker to grow than old roots, are smaller and more economical to handle, and are apparently more productive than old stock. About nine-hundred pounds of one ounce roots, planted, at one foot intervals in rows three feet apart, are sufficient for an acre. Cultivated seed roots, because of their more uniform age and quality, are to be preferred to wild stock.

As yet, the depth and space of planting are a matter of judgment rather than knowledge. A large number of measurements made on thrifty one year old hills have shown the tuber systems to occupy a space of from 5 to 12 inches in diameter, and 6 to 10 inches deep, the small rootlets extending outward and downward from one to two feet further. Allowing for two years' growth, the seed roots should probably not be set less than 12 inches apart. As to depth, roots planted at 3 inches are more prompt to grow and appear more prosperous than those planted at 5 inches. The expense of harvesting a shallow crop should also be less. (Ariz. E. S. B. 21.)

While the wild growth is confined to the sands and sandy loams, it has been found that if the roots are planted shallow and irrigated, equally large crops are produced on quite heavy soils and the roots are as rich in tannic acid. The plant seems not to be particular as to the kind of soil provided it is kept sufficiently moist, and it may be found that sandy loams and rather heavy soils, may prove more profitable for growing the plant than lighter soils, owing to their greater fertility and more lasting qualities without fertilization.

On new desert land, cultivation of the crop will consist of running a cultivator between the rows after each irrigation. On old land that has become set with weeds, some extra work may be necessary to keep them down, but as the ground is prepared during the summer and the growth occurs in the winter and spring, the ground being shaded during the latter stage of growth, weeds will not interfere seriously. The cultivation of canaigre is somewhat like the growing of the sugar beet.—(Ariz. E. S. B. 7.)

Commencing to irrigate by the first of October, a crop of ten tons to the acre is a reasonable estimate for new land if the soil is fairly well prepared, and a good stand is secured by planting selected tubers of wild growth. The second year's crop, from cultivated tubers one year old, should reach fifteen tons, and twenty tons is within the possibilities on good land carefully planted and well taken care of. With the field cleared, leveled and put in

shape to be irrigated, and seed on the ground, the cost of growing is somewhat as follows:

Plowing and preparing land per acre	$3.00
Planting with machine	2.00
Irrigating and cultivating	8.00
Digging with machine	2.00
Water rental	1.50
Total	$16.50

Cost of hauling roots from field would depend on distance to factory or station. Cost of seed is not included, for the seed roots planted will be harvested with the new growth and are richer in tannic acid than when planted. This estimate is for growing fields of from 100 acres up, sufficient area to warrant the use of the necessary machinery. On plantations of 1,000 acres or more, stationary and portable tramways with horse cars, such as are in use on the large sugar plantations in Louisiana and Texas, will be desirable to reduce cost of hauling roots from the field to the factory. With the tramway the plantations may extend several miles from the factory without making the cost of delivering prohibitive.—(Ariz. E. S. B. 7.)

Certain peculiarities of canaigre seem favorable to its agricultural future: 1. It grows in winter, when water is more abundant throughout the arid region. This fact may render possible the reclamation of large tracts of land for which there is not sufficient irrigation in summer. 2. The climate is mild at this season of year and labor is therefore more comfortable and effective. 3 In case of extreme drouth the crop is not lost but the plant simply stops growth and waits for better conditions. 4. Harvesting may occur at any time, the mature crop remaining in the ground indefinitely without injury, and even with a certain amount of improvement.—(Ariz. E. S. B. 21.)

So far as analyzed, the tannin in Canaigre roots ranks higher by many per cent than oak or hemlock barks, sumac, pine, elm, horse chestnut, valonia, kino, divi-divi, plum, and pear, but less than the renowned gambier, catechu, and nutgalls, the last of which, contains as high as 65 per cent tannic acid or twice that of the Canaigre. According to the tanner's reports, all these materials have different effects on leather, or in other words, tan leather of different grades, some making different colors and different leathers in quality. Canaigre differs from all these and all others in its tanning effects and is so superior that it commends itself prominently to all who are in any way interested in the leather business.—(N. Mex. E. S. B. 14.)

Assuming that it will cost $3 a ton to raise Canaigre, which is a higher estimate than is usually given, and that it can be sold at $5 per ton, a crop of only ten tons to the acre would bring a profit of twenty dollars per acre, not counting interest on the investment or cost of repairs. When the work of raising Canaigre is compared with that of the common field crops of the arid South-

A FINE BED OF MUSHROOMS GROWN FROM SPAWN OF PURE-CULTURE ORIGIN. BUL. 85, B. P. I.

(See pages 650-658.)

west or even fruit, it will be found that more money can be made, that the former will be more lucrative and will pay better in every way than the latter. Then, with Canaigre, the farmer is, to a large extent, independent of the weather conditions at the time of gathing, since a month or six weeks' difference of time will have no great influence.—(Tex. E. S. B. 38.; Ariz. E. S. B. 5; N. Mex. E. S. B. 11.)

THE BANANA.

The banana may well be reckoned the most important of all fruits since it is one of the principal food staples of many millions of the inhabitants of the tropics, and is also exported to temperate regions in rapidly increasing quantities, far exceeding in amount and value any similar product. Banana cultivation in the tropical islands of the United States is one of the most productive agricultural exploitations.

The agriculture of the Tropics resembles that of temperate regions to the extent that large profits depend upon favorable natural conditions, skillful and industrious farming, adequate and cheap labor, accessible markets, good prices, and numerous other contingencies. The most important difference between agriculture in the Tropics and agriculture in temperate regions does not lie in the greater security or larger profits of tropical agriculture, but in the fact that the attendant difficulties, being less known, are less easily anticipated and less easily overcome. It is true that the profits of successful tropical agriculture are sometimes very large, but it is also plain that this would not be the case if the art by which they are obtained were as easy as often supposed.—(Y. B. 1901.)

There are many different kinds of plantains, the banana, the one most usually brought to the American markets, being the kind which grows best and yields the most fruit. It requires good soil and little water, for it brings humidity to the ground, perhaps because of the large leaves sucking the moisture of the air, which runs through the plant, or because it brings up the underground deep waters to the surface. Whatever be the cause, the ground is always moist in a banana plantation, however great the drought.

When planted in new soil the banana does not require any plowing, but it does when the lands have been much used and have, of course, lost their natural state of porosity. When once the soil is ready, holes are made 1 yard in diameter, 2 or 3 yards distant from one another, and about one-half a yard deep. In rich lands and new lands no fertilizer is required, but otherwise a basketful of some kind is useful; a sprout is then planted, which in three months' time will grow to 8 and 10 feet high, and nine months or a year after planting, according to the variety, will yield fruit in the form of a bunch, which will count as many sometimes as 200 bananas.

In most places no water is required, but half a dozen irrigations a year will be enough in the driest lands. Once the plantation is in full growth and producing condition, it does not require

more attention than the cleaning of the plants of their dry leaves and the keeping of all the detritus from the plants well gathered round the trunk to fertilize it, allowing plenty of space for the new sprouts to come out. Sometimes these come in such profusion, that the expert laborer has to extirpate them and only allow a certain number to grow up. When the plantation is in full growth and production the collecting of the fruit is constant, and every week the plantation can be gone through to collect the ripe bunches. As if nature had provided it, the largest bunches contain fruit of the most delicate flavor, with sweetness and fine pulp, and they also are those that keep the best, lasting for many days, thus giving sufficient time for transportation. The dry leaves and trunks of the plants are useful for paper manufacture. When the bunch of bananas is ripe the tree or stalk, often 10 inches in diameter and 20 feet high, is cut down with a single stroke of the machete; the stump dies, but numerous sprouts are ready to take its place and the plantation constantly renews itself. Many are in good production for a half century or more, and wherever there is a suitable transportation for so heavy a crop it is very profitable. The trunks are cut in pieces and piled around the tree for fertilizing.—(Y. B. 1898; B. P. I. B. 198; Hawaii E. S. Rep. 1906.)